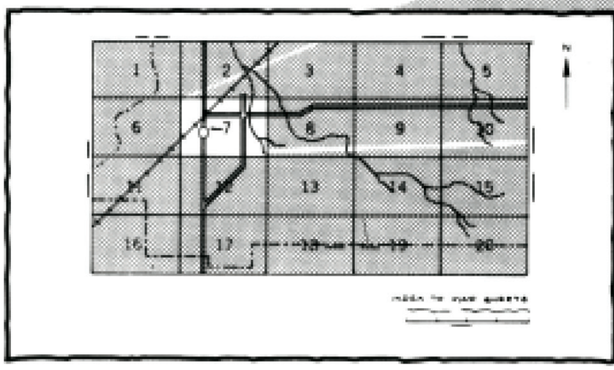
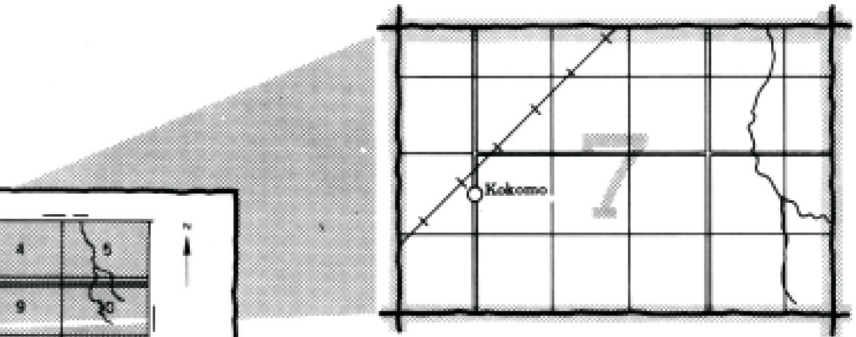
Soil Survey of
Bourbon County, Kansas

United States Department of Agriculture
Soil Conservation Service
in cooperation with
Kansas Agricultural Experiment Station

HOW TO USE

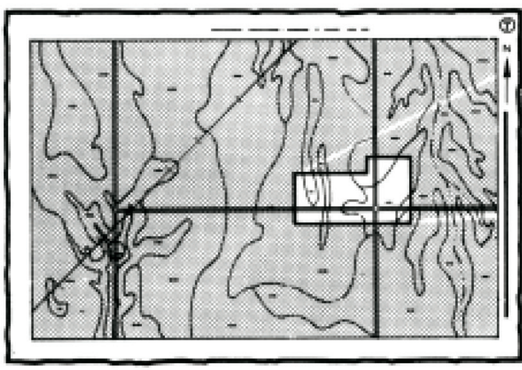
1. Locate your area of interest on the "Index to Map Sheets"

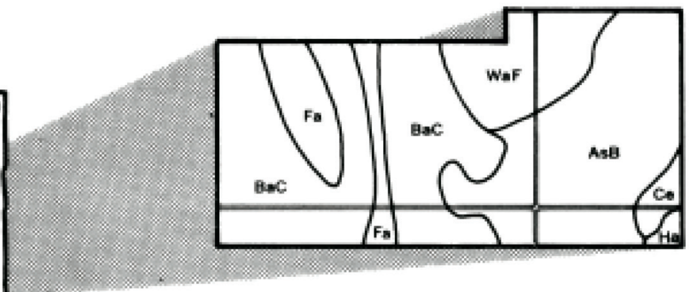




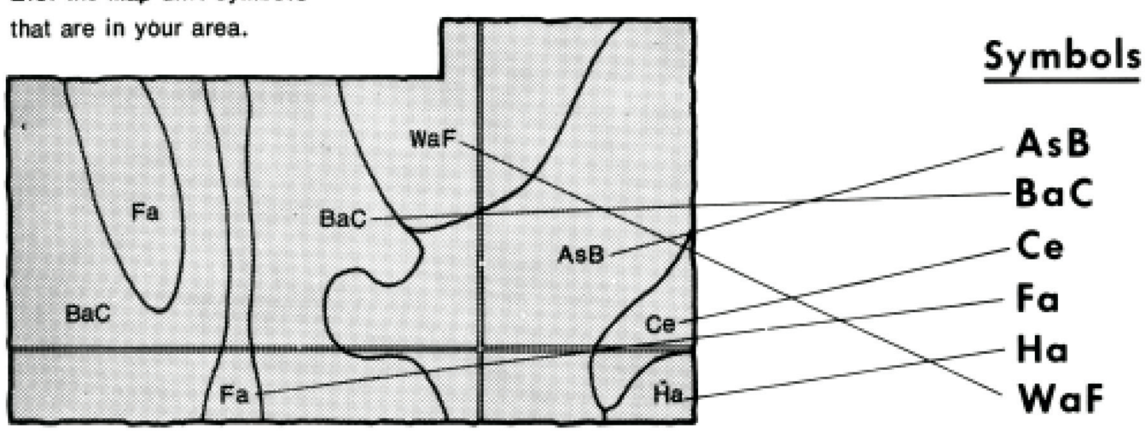
2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.



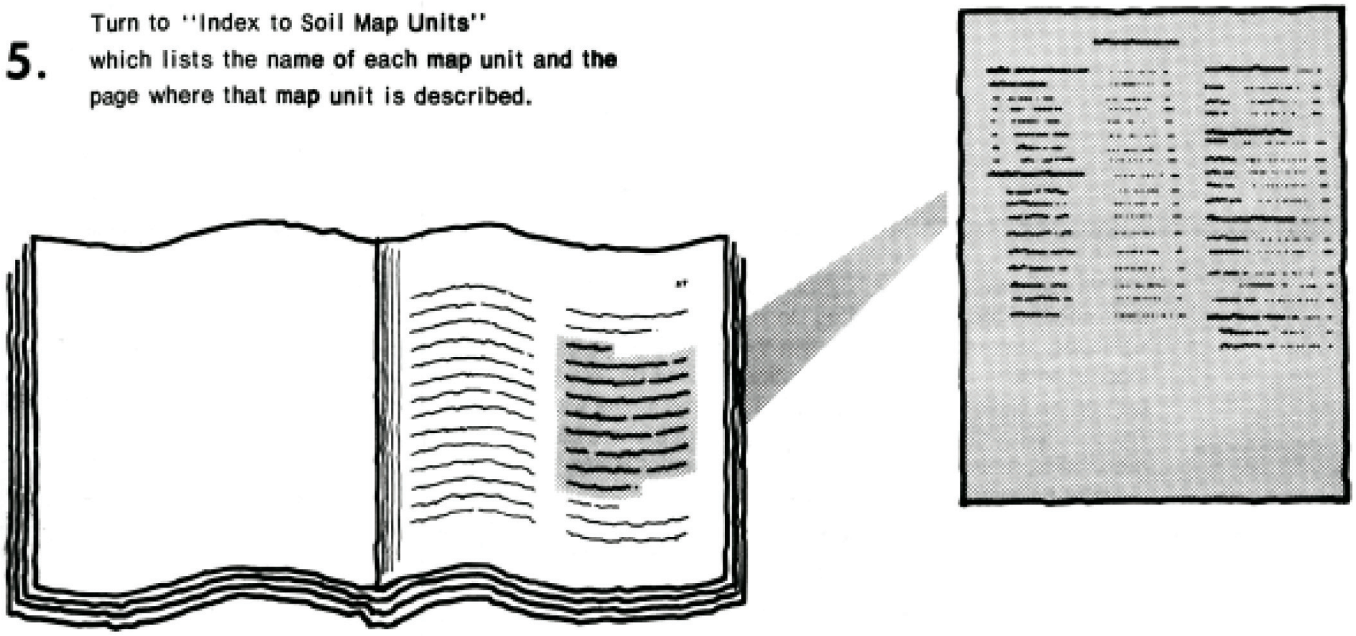


4. List the map unit symbols that are in your area.

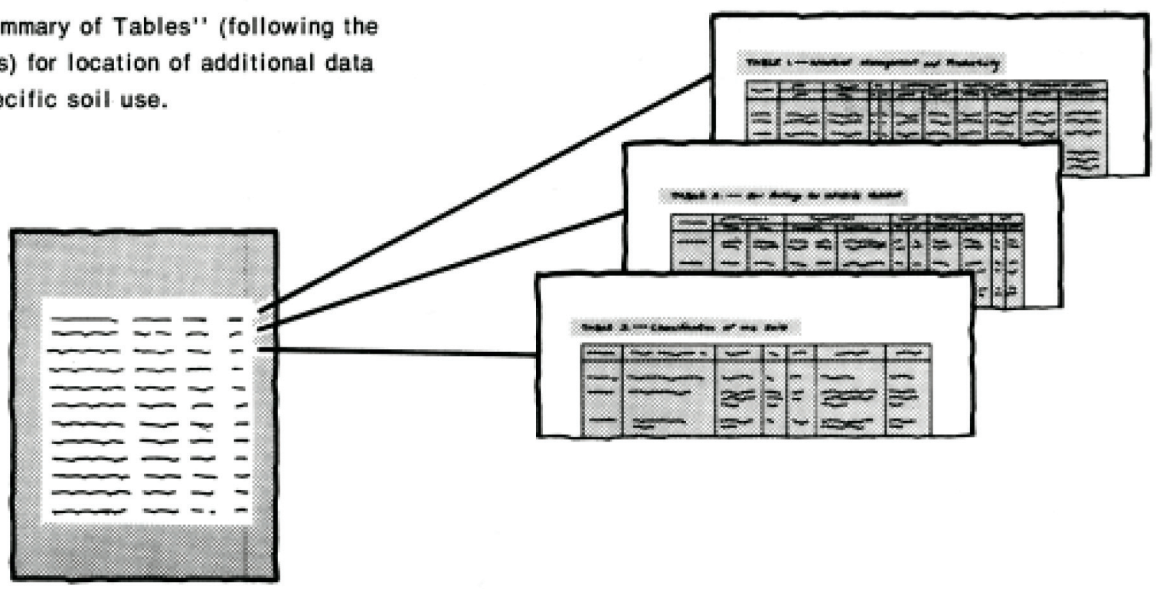


THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; to specialists in wildlife management, waste disposal, or pollution control.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

This survey was made cooperatively by the Soil Conservation Service and the Kansas Agricultural Experiment Station. It is part of the technical assistance furnished to the Bourbon County Conservation District. Major fieldwork was performed in the period 1972-77. Soil names and descriptions were approved in 1979. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1978.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

Cover: Verdigris and Lanton soils along a stream channel. Clareson soils are on the steeper side slopes.

contents

soil series

Issued February 1981

index to map units

summary of tables

foreword

This soil survey contains information that can be used in land-planning programs in Bourbon County, Kansas. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations inherent in the soil or hazards that adversely affect the soil, improvements needed to overcome the limitations or reduce the hazards, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

John W. Tippie

John W. Tippie
State Conservationist
Soil Conservation Service

soil survey of
Bourbon County, Kansas

By Elbert L. Bell and Jim R. Fortner, Soil Conservation Service

United States Department of Agriculture, Soil Conservation Service,

in cooperation with the Kansas Agricultural Experiment Station

general nature of the county

BOURBON COUNTY is in east-central Kansas (fig. 1). It has a total area of 408,960 acres, or 638 square miles The population was 16,613 in 1978. In that year, Fort Scott, the county seat, had a population of 9,511.

All of Bourbon County is in the Cherokee Prairies land resource area. The landscape is a slightly dissected plain that is interrupted by a series of low ridges formed by east-facing escarpments. The soils generally are moderately deep and deep and have a silty or clayey subsoil. Elevation ranges from 770 to 1,110 feet above sea level.

Most of the county is drained by the Marmaton and Little Osage Rivers and Drywood Creek, all of which are permanent streams. The waters in these streams flow eastward into Missouri.

The main enterprises in the county are farming and ranching. Some coal is mined, and more may be mined in the future. Quarrying of limestone rock is another important enterprise. Numerous small commercial and industrial plants provide many jobs.

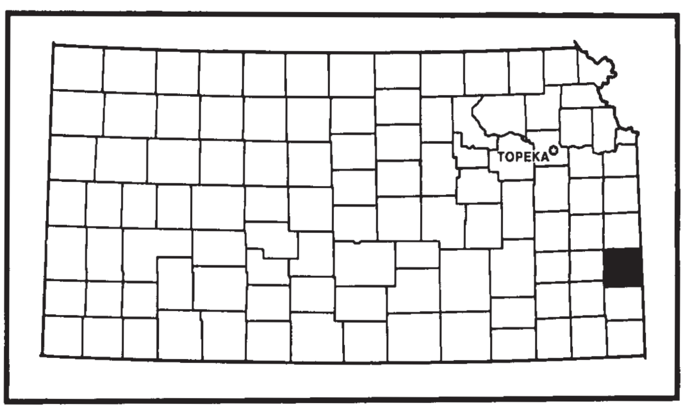


Figure 1.—Location of Bourbon County in Kansas.

This survey updates the soil survey of Bourbon County, Kansas, published in 1931 (*3*). It provides additional information and larger maps, which show the soils in greater detail.

climate

By L. Dean Bark, climatologist, Kansas Agricultural Experiment Station, Manhattan, Kansas.

The climate of Bourbon County is typical continental, as can be expected of a location in the interior of a large land mass in the middle latitudes. It is characterized by large daily and annual variations in temperature. Winters are cold because of frequent outbreaks of polar air. Cold temperatures last from December to February. Warm summer temperatures last for about 6 months every year. They provide a long growing season for the crops commonly grown in the county. Spring and fall generally are short.

Bourbon County is in the path of a current of moisture-laden air from the Gulf of Mexico. Precipitation is heaviest late in spring and early in summer. Much of it falls during late evening or nighttime thunderstorms. Although the total precipitation is generally adequate for any crop, its distribution causes problems in some years. Prolonged dry periods of several weeks can occur during the growing season. A surplus of precipitation often results in muddy fields, which delay planting and harvesting.

Tornadoes and severe thunderstorms occur occasionally. These storms usually are local in extent and of short duration, so that the risk of crop damage is small. Hail falls infrequently during the warmer part of the

year. It also is local in extent. It causes less crop damage than the hailstorms in western Kansas.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Fort Scott in the period 1941 to 1970. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

The average annual temperature is 58.3 degrees F. In winter, the average daily minimum temperature is 25.5 degrees. The lowest temperature, which occurred at Fort Scott on February 13, 1905, is -24 degrees. In summer the average temperature is 79.4 degrees, and the average daily maximum temperature is 91.0 degrees. The highest recorded temperature, which occurred at Fort Scott on July 13, 1954, is 120 degrees.

The total annual precipitation is 39.88 inches. Of this, 27.60 inches, or 69 percent, usually falls in April through September, which includes the growing season for most crops. In 2 years out of 10, the rainfall in April through September is less than 20.05 inches. The heaviest 1-day rainfall was 8.00 inches at Fort Scott on September 16, 1911.

Average seasonal snowfall is 16.3 inches. The greatest snow depth at any one time during the period of record was 20 inches. On an average of 18 days, at least 1 inch of snow is on the ground. The number of such days varies greatly from year to year.

The sun shines 70 percent of the time possible in summer and 55 percent in winter. The prevailing wind is from the south. Average windspeed is highest, 13 miles per hour, in March.

how this survey was made

Soil scientists made this survey to learn what soils are in the survey area, where they are, and how they can be used. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; and the kinds of rock. They dug many holes to study soil profiles. A profile is the sequence of natural layers, or horizons, in a soil. It extends from the surface down into the parent material, which has been changed very little by leaching or by plant roots.

The soil scientists recorded the characteristics of the profiles they studied and compared those profiles with others in nearby counties and in more distant places. They classified and named the soils according to nationwide uniform procedures. They drew the boundaries of the soils on aerial photographs. These photographs show trees, buildings, fields, roads, and other details that help in drawing boundaries accurately. The soil maps at the back of this publication were prepared from aerial photographs.

The areas shown on a soil map are called map units. Most map units are made up of one kind of soil. Some are made up of two or more kinds. The map units in this survey area are described under "General soil map units" and "Detailed soil map units."

While a soil survey is in progress, samples of some soils are taken for laboratory measurements and for engineering tests. All soils are field tested to determine their characteristics. Interpretations of those characteristics may be modified during the survey. Data are assembled from other sources, such as test results, records, field experience, and state and local specialists. For example, data on crop yields under defined management are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it can be used by farmers, rangeland and woodland managers, engineers, planners, developers and builders, home buyers, and others.

general soil map units

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another association but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

The descriptions and names of the soils identified on the general soil map of this county do not fully agree with those of the soils identified on the general soil maps of adjacent counties. Differences result from a better knowledge of the soils, modifications in series concepts, a higher or lower intensity of mapping, and variations in the extent of the soils in the counties.

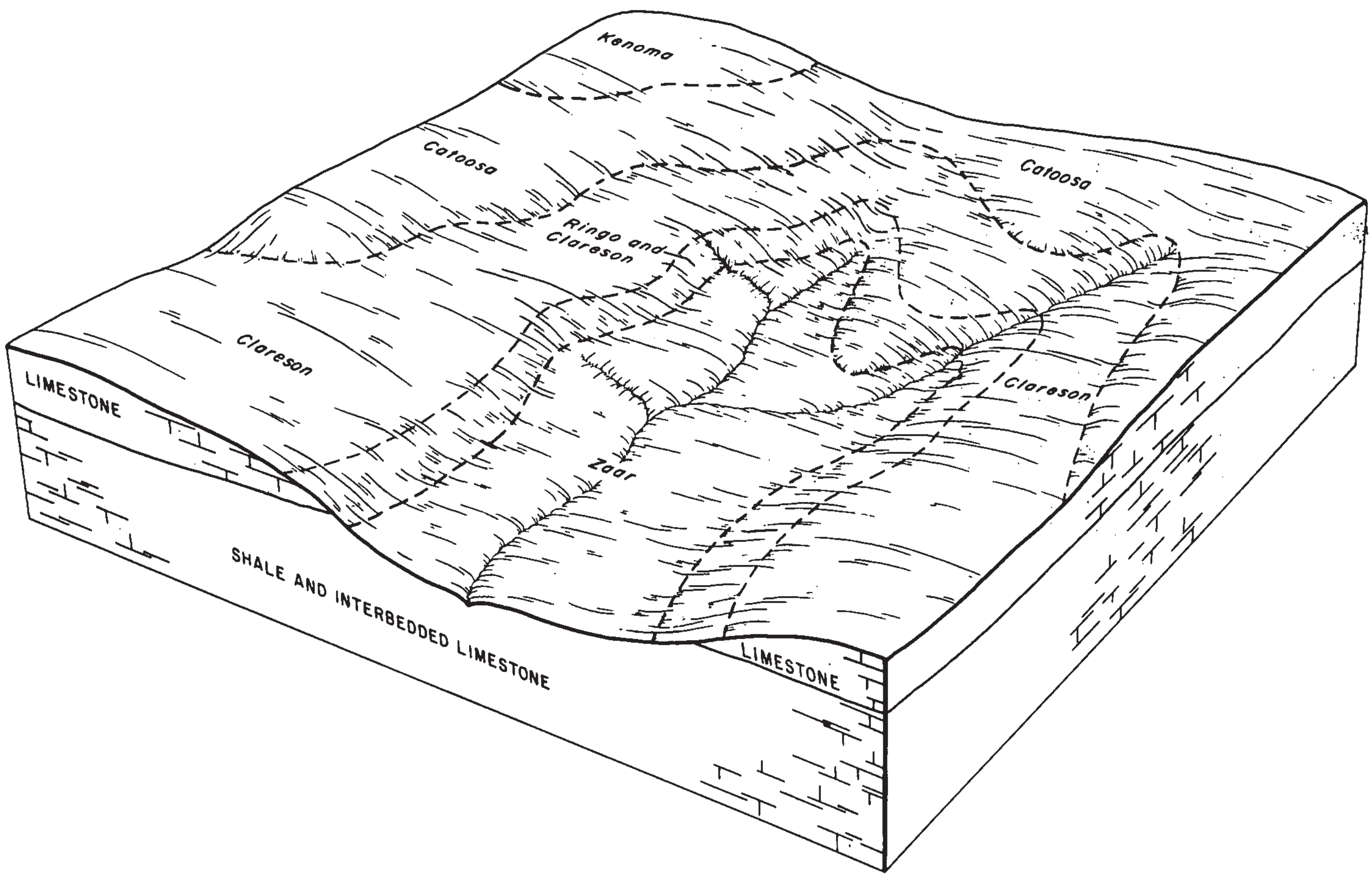


Figure 2.—Pattern of soils in the Clareson-Catoosa association.

soil descriptions

1. Clareson-Catoosa association

Moderately deep, nearly level and gently sloping, well drained soils that have a silty clay and silty clay loam subsoil; on uplands

This association is on broad upland divides and ridgetops formed by resistant limestone. The soils generally are nearly level and gently sloping but are steeper on side slopes and escarpments adjacent to streams.

This association makes up about 15 percent of the county. It is about 35 percent Clareson soils, 30 percent Catoosa soils, and 35 percent minor soils (fig. 2).

The Clareson soils formed in material weathered from limestone on side slopes. Typically, the surface layer is very dark brown stony silty clay loam about 10 inches thick. The subsoil is about 22 inches thick. The upper part is very dark brown, very firm flaggy silty clay loam. The lower part is dark reddish brown, very firm flaggy silty clay. Bedrock is at a depth of about 32 inches.

The Catoosa soils formed in material weathered from limestone on ridgetops. Typically, the surface soil is very dark grayish brown silt loam about 14 inches thick. The subsoil is silty clay loam about 22 inches thick. The upper part is dark brown and friable. The next part is reddish brown and firm. The lower part is dark brown and firm, and it contains limestone fragments. Bedrock is at a depth of about 36 inches.

Minor in this association are the moderately well drained Kenoma soils on ridges, the moderately well drained Ringo soils on side slopes, and the somewhat poorly drained Zaar soils on foot slopes.

About half of this association is range. The rest generally is cultivated. Grain sorghum, wheat, and soybeans and grasses and legumes for hay and pasture are the main crops. Erosion is a hazard in the gently sloping areas. Measures that control brush on the range and erosion in the cultivated areas are the main management needs.

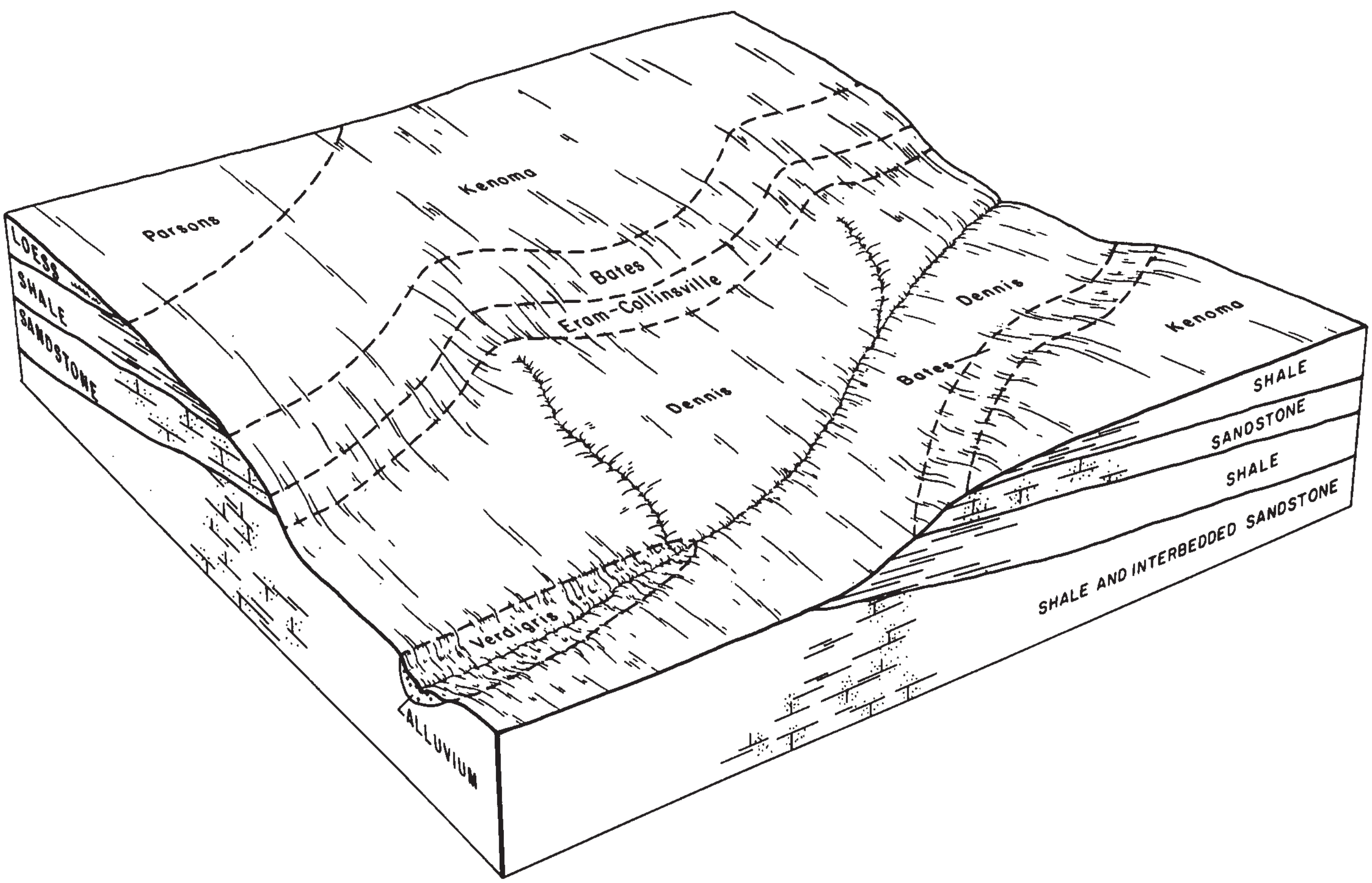


Figure 3.—Pattern of soils in the Dennis-Kenoma association.

2. Dennis-Kenoma association

Deep, gently sloping and moderately sloping, moderately well drained soils that have a silty clay and silty clay loam subsoil; on uplands

This association is on ridgetops and foot slopes on uplands that are dissected by intermittent drainageways. It makes up about 30 percent of the county. It is about 35 percent Dennis soils, 25 percent Kenoma soils, and 40 percent minor soils (fig. 3).

The Dennis soils formed in material weathered from shale on foot slopes. Typically, the surface soil is very dark grayish brown silt loam about 15 inches thick. The subsoil extends to a depth of 60 inches or more. The upper part is dark brown, firm silty clay loam. The next part is dark brown and dark grayish brown, mottled, very firm silty clay. The lower part is yellowish brown, mottled, very firm silty clay loam.

The Kenoma soils formed in old alluvial sediments and material weathered from shale on ridgetops. Typically, the surface layer is very dark grayish brown silt loam about 8 inches thick. The subsoil is mottled, very firm silty clay about 42 inches thick. The upper part is dark brown, and the lower part is dark grayish brown. The underlying material to a depth of 60 inches is light brownish gray, mottled, firm silty clay loam.

Minor in this association are Bates, Collinsville, Eram, Parsons, and Verdigris soils. The well drained Bates soils are on ridges and side slopes. The well drained Collinsville and moderately well drained Eram soils are on side slopes. The somewhat poorly drained Parsons soils are on broad ridgetops. The well drained, occasionally flooded Verdigris soils are along drainageways.

About two-thirds of this association is cultivated. The rest dominantly is range. Grain sorghum, wheat, and soybeans and grasses and legumes for hay and pasture are the main crops. Controlling erosion and improving tilth and fertility are the main concerns of management.

3. Verdigris-Lanton association

Deep, nearly level, well drained and somewhat poorly drained soils that have a silt loam and silty clay loam subsoil; on flood plains

This association is on flood plains along the rivers and larger creeks in the county. The landscape is cut by meandering stream channels. The soils are occasionally flooded. In some areas adjacent to the uplands, they are poorly drained.

This association makes up about 10 percent of the county. It is about 50 percent Verdigris soils, 25 percent Lanton soils, and 25 percent minor soils.

The well drained Verdigris soils formed in silty alluvium. Typically, the surface soil is very dark grayish brown silt loam about 22 inches thick. The next 22 inches is dark brown, friable silt loam. The underlying material to a depth of about 60 inches is dark brown silt loam.

The somewhat poorly drained Lanton soils formed in alluvium. Typically, the surface layer is very dark grayish brown silty clay loam about 8 inches thick. The subsurface layer is black silty clay loam about 18 inches thick. The next 10 inches is very dark gray, firm silty clay loam. The upper part of the underlying material is very dark gray silty clay loam. The lower part to a depth of 60 inches is gray silty clay.

Minor in this association are Leanna, Mason, and Osage soils. The poorly drained, occasionally flooded Leanna soils are on low stream terraces. The well drained, rarely flooded Mason soils are on stream terraces. The poorly drained, occasionally flooded, clayey Osage soils are on flood plains.

Most of this association is cultivated. Some small areas are used as woodland or pasture. The major soils are suited to corn, grain sorghum, wheat, and soybeans and to grasses and legumes for hay and pasture. Flooding and wetness limit the choice of crops and delay spring planting in some areas. The main management needs are measures that improve surface drainage, increase the content of organic matter, and keep the soils in good tilth.

4. Zaar-Catoosa-Clareson association

Deep and moderately deep, nearly level to strongly sloping, somewhat poorly drained and well drained soils that have a silty clay and silty clay loam subsoil; on uplands

This association is on ridgetops, side slopes, and foot slopes on uplands that are dissected by drainageways and small creeks. It makes up about 45 percent of the county. It is about 25 percent Zaar soils, 20 percent Catoosa soils, 20 percent Clareson soils, and 35 percent minor soils (fig. 4).

The deep, somewhat poorly drained Zaar soils formed in material weathered from shale on foot slopes. Typically, the surface soil is black silty clay about 15 inches thick. The subsoil is very firm, mottled silty clay about 33 inches thick. The upper part is black, and the lower part is very dark grayish brown and dark grayish brown. The underlying material to a depth of about 60 inches is dark grayish brown, mottled silty clay.

The moderately deep, well drained Catoosa soils formed in material weathered from limestone on ridgetops. Typically, the surface soil is very dark grayish brown silt loam about 14 inches thick. The subsoil is silty clay loam about 22 inches thick. The upper part is dark brown and friable. The next part is reddish brown and firm. The lower part is dark brown and firm, and it contains limestone fragments. Bedrock is at a depth of about 36 inches.

The moderately deep, well drained Clareson soils formed in material weathered from limestone on side slopes. Typically, the surface layer is very dark brown

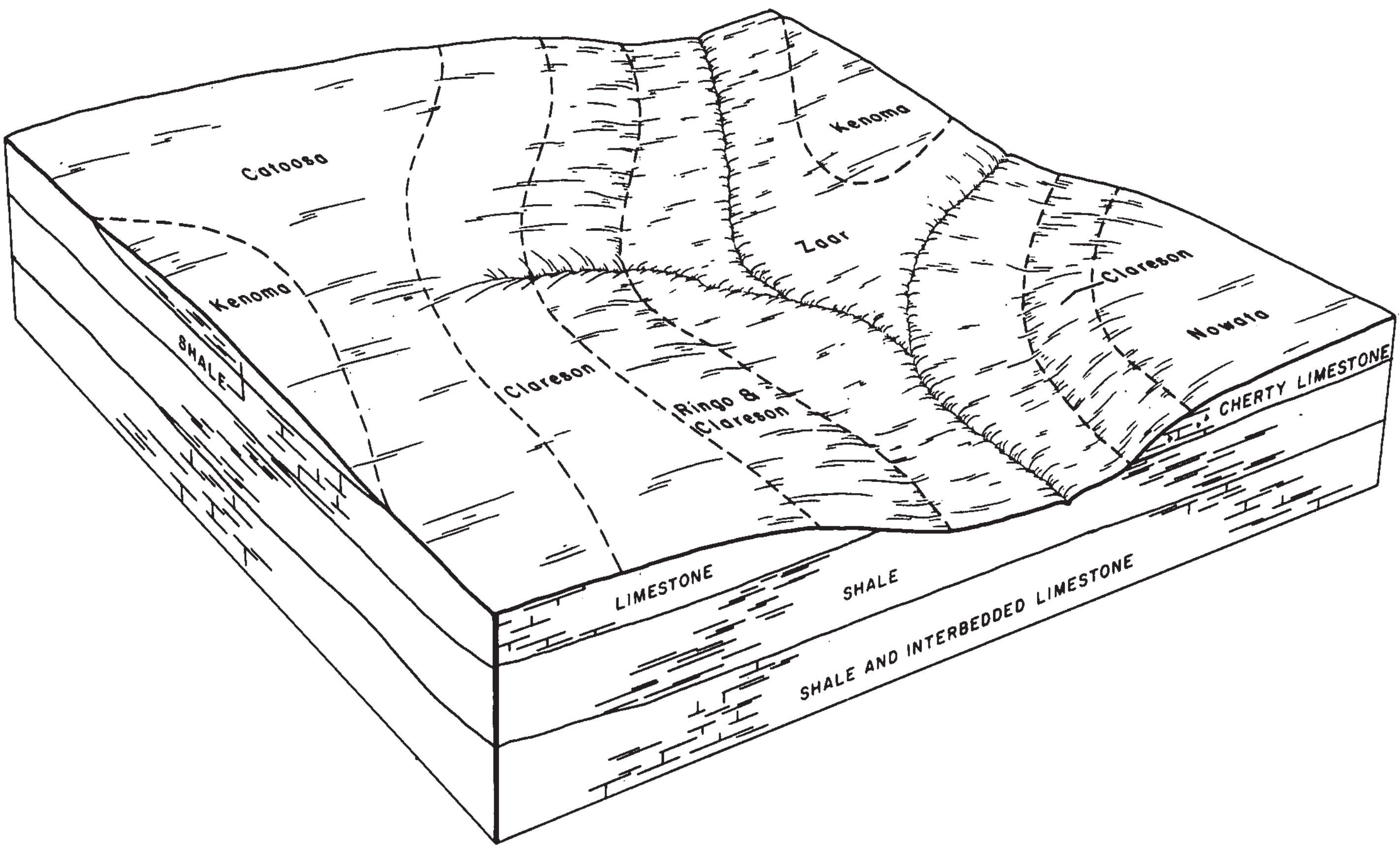


Figure 4.—Pattern of soils in the Zaar-Catoosa-Clareson association.

stony silty clay loam about 10 inches thick. The subsoil is about 22 inches thick. The upper part is very dark brown, very firm flaggy silty clay loam. The lower part is dark reddish brown, very firm flaggy silty clay. Bedrock is at a depth of about 32 inches.

Minor in this association are Kenoma, Nowata, and Ringo soils. The deep, moderately well drained Kenoma and moderately deep, well drained Nowata soils are on the ridgetops. The moderately deep, moderately well drained Ringo soils are on the steeper side slopes.

About two-thirds of this association is range. The rest generally is cultivated. The main management needs are measures that control erosion, conserve moisture, and keep the range in good condition.

detailed soil map units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and management of the soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and identifies the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the underlying material, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Bates loam, 4 to 7 percent slopes, eroded, is one of several phases in the Bates series.

Some map units are made up of two or more major soils. These map units are called soil complexes. A *soil complex* consists of two or more soils that occur as areas so intricately mixed or so small that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Ringo-Clareson complex, 9 to 15 percent slopes, is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. These dissimiliar soils are described in each map unit. Also, some of the more unusual or strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes some *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits, quarries, is an example. Some miscellaneous areas are large enough to be delineated on the soil maps. Some that are too small to be delineated are identified by a special symbol on the soil maps.

The descriptions and names of the soils identified on the detailed maps of this county do not fully agree with those of the soils identified on the maps of adjacent counties. Differences result from a better knowledge of the soils, modifications in series concepts, a higher or lower intensity of mapping, and variations in the extent of the soils in the counties.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

soil descriptions

Ba—Bates loam, 1 to 4 percent slopes. This gently sloping, well drained soil is on the tops of ridges in the uplands. Individual areas are irregular in shape and range from 5 to 50 acres in size.

Typically, the surface soil is very dark grayish brown loam about 12 inches thick. The subsoil is about 23 inches thick. The upper part is dark brown, friable loam. The next part is dark brown, firm sandy clay loam. The lower part is strong brown, firm sandy loam. Bedrock is at a depth of about 35 inches. In some areas the depth to bedrock is less than 20 inches.

Included with this soil in mapping are small areas of the moderately well drained Kenoma soils on ridgetops. These soils make up about 10 percent of the map unit.

Permeability and available water capacity are moderate in the Bates soil. Surface runoff is medium. The content of organic matter is moderately low, and natural fertility is medium. The surface layer is friable and can be easily tilled. The root zone is restricted by the bedrock at a depth of about 35 inches.

About half of the acreage is cultivated. The rest dominantly is range or pasture. This soil is moderately well suited to wheat, grain sorghum, and soybeans and to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a hazard. Minimum tillage, terraces, contour farming, and grassed waterways help

to prevent excessive soil loss and conserve moisture. Returning crop residue to the soil increases the content of organic matter and the infiltration rate.

This soil is well suited to range. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates and rotation grazing help to keep the range in good condition.

This soil is suitable as a site for dwellings without basements and for local roads and streets. It generally is unsuitable as a site for septic tank absorption fields and sewage lagoons, however, because the depth to rock is a severe limitation. The deeper, less sloping included or adjacent soils on foot slopes or ridges are suitable sites for lagoons.

The capability subclass is IIe.

Bc—Bates loam, 4 to 7 percent slopes. This moderately sloping, well drained soil is on ridges and side slopes in the uplands. Individual areas are irregular in shape and range from 5 to 40 acres in size.

Typically, the surface layer is very dark grayish brown loam about 10 inches thick. The subsoil is about 18 inches thick. The upper part is dark brown, friable loam. The next part is dark brown, firm sandy clay loam. The lower part is strong brown, firm sandy loam. Bedrock is at a depth of about 28 inches. In places the surface layer is dark brown sandy clay loam. In some areas the depth to bedrock is less than 20 inches.

Included with this soil in mapping are small areas of the deep Dennis and Kenoma soils. These soils make up about 15 percent of the map unit. They are more clayey than the Bates soil. The Dennis soils are on foot slopes, and the Kenoma soils are on ridgetops.

Permeability and available water capacity are moderate in the Bates soil. Surface runoff is medium. The content of organic matter is moderately low, and natural fertility is medium. The surface layer is friable and can be easily tilled. The root zone is restricted by the bedrock at a depth of about 28 inches.

About one-fourth of the acreage is cultivated. The rest dominantly is range or pasture. This soil is moderately well suited to wheat, grain sorghum, and soybeans and to grasses and legumes for hay and pasture. If cultivated crops are grown, erosion is a hazard. Minimum tillage, grassed waterways, terraces, and contour farming help to prevent excessive soil loss and conserve moisture. Returning crop residue to the soil increases the content of organic matter and the infiltration rate.

This soil is well suited to range. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates and rotation grazing help to keep the range in good condition.

This soil is suitable as a site for dwellings without basements and for local roads and streets. It generally is unsuitable as a site for septic tank absorption fields and sewage lagoons, however, because the depth to rock is a severe limitation. The deeper, less sloping included or adjacent soils on foot slopes are suitable sites for lagoons.

The capability subclass is IIIe.

Bd—Bates loam, 4 to 7 percent slopes, eroded. This moderately sloping, well drained soil is on ridges and side slopes in the uplands. Individual areas are irregular in shape and range from 5 to 40 acres in size.

Erosion has removed most of the original surface layer. Typically, the surface layer is very dark grayish brown loam about 5 inches thick. The subsoil is dark yellowish brown, firm sandy clay loam about 18 inches thick. Bedrock is at a depth of about 23 inches. In places the surface layer is dark brown sandy clay loam. In some areas the depth to bedrock is less than 20 inches.

Included with this soil in mapping are small areas of the deep Dennis and Kenoma soils. These soils make up about 15 percent of the map unit. They are more clayey than the Bates soil. The Dennis soils are on foot slopes, and the Kenoma soils are on ridgetops.

Permeability is moderate in the Bates soil, and available water capability is low. Surface runoff is medium. The content of organic matter is moderately low, and natural fertility is low. The surface layer is friable and can be easily tilled. The root zone is restricted by the bedrock at a depth of about 23 inches.

Most of the acreage is range or pasture. The rest generally is cultivated. This soil is well suited to range. The major concerns in managing range are erosion and low forage production on abandoned cropland. An adequate plant cover and ground mulch reduce the runoff rate, help to prevent excessive soil loss, and increase the moisture supply. Overgrazing destroys the protective plant cover and causes deterioration of the plant community. Under these conditions, the more desirable grasses are replaced by less productive mid and short grasses and by weeds. Reseeding abandoned cropland with desirable mid and tall grasses increases forage production. Proper stocking rates, deferred grazing, and brush control help to keep the range in good condition.

This soil is moderately well suited to wheat and grain sorghum and to grasses and legumes for hay and pasture. Further erosion is a hazard if cultivated crops are grown. Minimum tillage, grassed waterways, terraces, and contour farming help to prevent excessive soil loss and conserve moisture. Returning crop residue to the soil improves fertility and increases the content of organic matter and the infiltration rate.

This soil is suitable as a site for dwellings without basements and for local roads and streets. It generally is unsuitable as a site for septic tank absorption fields and sewage lagoons, however, because the depth to rock is a severe limitation. The deeper, less sloping included or adjacent soils on foot slopes are suitable sites for lagoons.

The capability subclass is IVe.

Bh—Bolivar-Hector fine sandy loams, 5 to 15 percent slopes. These moderately sloping to

moderately steep, well drained soils are on uplands. The strongly sloping and moderately steep Bolivar soil is on side slopes, and the moderately sloping Hector soil is on narrow ridgetops. Individual areas are long and narrow or irregularly shaped and range from 20 to 75 acres in size. They are 65 to 85 percent Bolivar soil and 15 to 35 percent Hector soil. The two soils occur as areas so small or so intricately mixed that mapping them separately is not practical.

Typically, the Bolivar soil has a surface layer of very dark grayish brown fine sandy loam about 5 inches thick. The subsurface layer is dark brown fine sandy loam about 7 inches thick. The subsoil is about 22 inches thick. It contains sandstone fragments. The upper part is dark brown, friable loam. The next part is brown, friable sandy clay loam. The lower part is dark grayish brown and strong brown, friable loam. Bedrock is at a depth of about 34 inches. In some areas the surface layer is more than 7 inches thick.

Typically, a layer of partly decomposed leaves and twigs about 2 inches thick is at the surface of the Hector soil. The surface layer is dark brown fine sandy loam about 3 inches thick. The subsurface layer is brown, very friable fine sandy loam about 4 inches thick. The subsoil is brown, very friable fine sandy loam about 5 inches thick. It contains sandstone fragments. Bedrock is at a depth of about 12 inches.

Included with these soils in mapping are small areas of the deep Dennis and Kenoma soils. These included soils make up 10 to 20 percent of the unit. They are more clayey than the Bolivar and Hector soils. The Dennis soils are on foot slopes, and the Kenoma soils are on ridgetops.

Permeability is moderate in the Bolivar soil and moderately rapid in the Hector soil. Surface runoff is rapid on both soils. Available water capacity is low in the Bolivar soil and very low in the Hector soil. The root zone is restricted by the bedrock at a depth of about 34 inches in the Bolivar soil and 12 inches in the Hector soil. The shrink-swell potential is moderate in the Bolivar soil and low in the Hector soil.

Most of the acreage is woodland and is used for grazing. These soils are moderately well suited to trees. Most of the trees are used for firewood or charcoal. Measures that prevent grazing in wooded areas help to keep forest litter on the surface and conserve moisture. Harvesting mature trees, thinning, and planting desirable species improve the woodland.

These soils are moderately well suited to range. The major concerns in managing range are the hazard of erosion, the low and very low available water capacity, and competing trees. An adequate plant cover and ground mulch reduce the runoff rate, help to prevent excessive soil loss, and increase the moisture supply. Overgrazing destroys the protective plant cover and causes deterioration of the plant community. Under these conditions, the more desirable grasses are replaced by less productive mid and short grasses and by weeds. Thinning the canopy, stocking at a proper rate, deferring grazing, and controlling brush help to keep the range in good condition.

The shrink-swell potential and slope of the Bolivar soil are moderate limitations on sites for dwellings without basements, and the depth to rock in the Hector soil is a severe limitation. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the structural damage caused by the shrinking and swelling of the Bolivar soil. The deeper included soils are better building sites.

These soils generally are unsuitable as septic tank absorption fields because the depth to rock is a severe limitation. The slope and the depth to rock are severe limitations on sites for sewage lagoons. The deeper, less sloping included soils on foot slopes or on the broader ridgetops are suitable sites for lagoons.

The low strength, slope, and shrink-swell potential of the Bolivar soil are moderate limitations on sites for local roads and streets, and the depth to rock in the Hector soil is a severe limitation. The adverse effects of low strength and shrinking and swelling can be lessened by strengthening or replacing the base material. Hauling in additional base material from borrow pits helps to overcome the depth to rock in the Hector soil.

The capability subclass is VIe.

Ca—Catoosa silt loam. This nearly level, well drained soil is on broad ridgetops in the uplands. Individual areas are long and narrow or irregularly shaped and range from 20 to 400 acres in size.

Typically, the surface soil is very dark grayish brown silt loam about 14 inches thick. The subsoil is silty clay loam about 22 inches thick. The upper part is dark brown and friable. The next part is reddish brown and firm. The lower part is dark brown and firm, and it contains limestone fragments. Bedrock is at a depth of about 36 inches. In some areas the surface layer is cherty silt loam.

Included with this soil in mapping are small areas of Clareson and Kenoma soils. These soils make up about 15 percent of the map unit. The Clareson soils have a stony surface layer. They are on side slopes. The deep Kenoma soils are on the tops of the higher ridges.

Permeability and available water capacity are moderate in the Catoosa soil. Surface runoff is medium. The content of organic matter is moderately low, and natural fertility is medium. The surface layer is friable and can be easily tilled. The root zone is restricted by the bedrock at a depth of about 36 inches. The shrink-swell potential is moderate.

Most of the acreage is cultivated. The rest dominantly is range. This soil is moderately well suited to wheat, grain sorghum, and soybeans and to grasses and legumes for hay and pasture. Erosion is a hazard if cultivated crops are grown. Minimum tillage, contour farming, grassed waterways, and terraces help to

prevent excessive soil loss and conserve moisture. Returning crop residue to the soil increases the content of organic matter and the infiltration rate.

This soil is well suited to range. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates and rotation grazing help to keep the range in good condition.

The depth to rock and the shrink-swell potential are moderate limitations if this soil is used as a site for dwellings without basements. The deeper included soils are better building sites. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the structural damage caused by shrinking and swelling. Low strength is a severe limitation on sites for local roads and streets. Strengthening or replacing the base material helps to overcome this limitation.

This soil generally is unsuitable as a site for septic tank absorption fields and sewage lagoons because the depth to rock is a severe limitation. The deeper included soils on the broader ridgetops are suitable sites for lagoons.

The capability subclass is IIe.

Cs—Clareson stony silty clay loam, 1 to 4 percent slopes. This gently sloping, well drained soil is on the upper sides of ridges in the uplands. Limestone rocks 1 to 2 feet in diameter cover 0.1 to 3.0 percent of the surface. Individual areas are irregular in shape and range from 50 to 1,000 acres in size.

Typically, the surface layer is very dark brown stony silty clay loam about 10 inches thick. The subsoil is about 22 inches thick. The upper part is very dark brown, very firm flaggy silty clay loam. The lower part is dark reddish brown, very firm flaggy silty clay. Bedrock is at a depth of about 32 inches. In some areas the surface layer contains no limestone fragments.

Included with this soil in mapping are small areas of Ringo soils on the lower side slopes. These soils make up about 10 percent of the map unit. They are moderately deep over shale.

Permeability is moderately slow in the Clareson soil, and available water capacity is low. Surface runoff is medium. The root zone is restricted by the bedrock at a depth of about 32 inches. Tilling is difficult because the surface layer is firm and because rocks are on the surface in most areas. The shrink-swell potential is moderate.

Almost all of the acreage is range. This soil generally is unsuited to cultivated crops because of the stony surface layer and droughtiness. It is best suited to range. The major concern in managing range is the droughtiness caused by the low available water capacity. An adequate plant cover and ground mulch reduce the runoff rate and increase the available water capacity. Overgrazing reduces the vigor and retards the growth of the grasses and causes deterioration of the plant community. Under these conditions, the more desirable grasses are replaced by less productive mid and short grasses and by weeds. Proper stocking rates, deferred grazing, and brush control help to keep the range in good condition.

The large stones are a severe limitation if this soil is used as a site for dwellings without basements. Excavation is easier if the buildings are constructed on deeper, less stony soils. Low strength and the large stones are severe limitations on sites for local roads and streets. Strengthening or replacing the base material helps to overcome these limitations.

This soil generally is unsuitable as a septic tank absorption field because the depth to rock, the large stones, and the moderately slow permeabilty are severe limitations. The depth to rock and the large stones are severe limitations on sites for sewage lagoons. The deeper adjacent soils are suitable sites for lagoons.

The capability subclass is VIs.

De—Dennis silt loam, 1 to 3 percent slopes. This gently sloping, moderately well drained soil is on foot slopes in the uplands. Individual areas are irregular in shape and range from 20 to 200 acres in size.

Typically, the surface soil is very dark grayish brown silt loam about 15 inches thick. The subsoil extends to a depth of about 60 inches or more. The upper part is dark brown, firm silty clay loam. The next part is dark brown and dark grayish brown, mottled, very firm silty clay. The lower part is yellowish brown, mottled, very firm silty clay loam.

Included with this soil in mapping are small areas of Eram and Verdigris soils. These soils make up about 15 percent of the map unit. The moderately deep Eram soils are on the upper side slopes. The frequently flooded Verdigris soils are along narrow drainageways.

Permeability is slow in the Dennis soil, and available water capacity is high. Surface runoff is medium. The content of organic matter is moderate, and natural fertility is medium. The surface layer is friable and can be easily tilled. A seasonal high water table is perched at a depth of 2 to 3 feet in winter and spring. The shrink-swell potential is high.

About two-thirds of the acreage is cultivated. The rest dominantly is range or pasture. This soil is well suited to soybeans, grain soghum, and wheat and to grasses and legumes for hay and pasture. Erosion is a hazard, however, if cultivated crops are grown. Minimum tillage, grassed waterways, terraces, and contour farming help to prevent excessive soil loss and conserve moisture. Returning crop residue to the soil increases the content of organic matter and the infiltration rate.

This soil is well suited to range. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates and rotation grazing help to keep the range in good condition.

The shrink-swell potential is a severe limitation if this soil is used as a site for dwellings. Properly designing and reinforcing foundations, installing foundation drains,

and backfilling with porous material help to prevent the structural damage caused by shrinking and swelling. Low strength and the shrink-swell potential are severe limitations on sites for local roads and streets. Strengthening or replacing the base material helps to overcome these limitations.

This soil generally is unsuitable as a septic tank absorption field because the slow permeability and the wetness are severe limitations. Sewage lagoons are a suitable alternative in many areas, but the slope is a moderate limitation. The less sloping included soils are better sites.

The capability subclass is IIe.

Df—Dennis silt loam, 3 to 6 percent slopes. This moderately sloping, moderately well drained soil is on foot slopes in the uplands. Individual areas are irregular in shape and range from 10 to 100 acres in size.

Typically, the surface soil is very dark grayish brown silt loam about 15 inches thick. The subsoil extends to a depth of about 60 inches or more. The upper part is dark brown, firm silty clay loam. The next part is dark brown and dark grayish brown, mottled, very firm silty clay. The lower part is yellowish brown, mottled, very firm silty clay loam. In some areas the surface layer is dark grayish brown silty clay loam.

Included with this soil in mapping are small areas of Bates and Verdigris soils. These soils make up about 15 percent of the map unit. The moderately deep Bates soils are on ridgetops. The well drained Verdigris soils are on flood plains along narrow drainageways.

Permeability is slow in the Dennis soil, and available water capacity is high. Surface runoff is medium. The content of organic matter is moderate, and natural fertility is medium. The surface layer is friable and can be easily tilled. A seasonal high water table is perched at a depth of 2 to 3 feet in winter and spring. The shrink-swell potential is high.

About half of the acreage is cultivated. The rest dominantly is range or pasture. This soil is well suited to soybeans, grain sorghum, and wheat and to grasses and legumes for hay and pasture. Erosion is a hazard, however, if cultivated crops are grown. Minimum tillage, grassed waterways, terraces, and contour farming help to prevent excessive soil loss and conserve moisture. Returning crop residue to the soil increases the content of organic matter and the infiltration rate.

This soil is well suited to range. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates and rotation grazing help to keep the range in good condition.

The shrink-swell potential is a severe limitation if this soil is used as a site for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the structural damage caused by shrinking and swelling. Low strength and the shrink-swell potential are severe limitations on sites for local roads and streets. Strengthening or replacing the base material helps to overcome this limitation.

This soil generally is unsuitable as a septic tank absorption field because the slow permeability and the wetness are severe limitations. The slope is a moderate limitation on sites for sewage lagoons. The less sloping included soils are better sites.

The capability subclass is IIIe.

Ec—Eram-Collinsville complex, 5 to 12 percent slopes. These strongly sloping soils are on uplands. The moderately well drained Eram soil is on side slopes, and the well drained Collinsville soil is on ridges. Individual areas are long and narrow or irregularly shaped and range from 20 to 75 acres in size. They are 70 to 90 percent Eram soil and 10 to 30 percent Collinsville soil. The two soils occur as areas so small or so intricately mixed that mapping them separately is not practical.

Typically, the surface layer of the Eram soil is very dark grayish brown silty clay loam about 10 inches thick. The subsoil is dark grayish brown, dark brown, grayish brown, and very dark grayish brown, mottled, very firm silty clay about 20 inches thick. Bedrock is at a depth of about 30 inches. In some areas the depth to bedrock is less than 20 inches.

Typically, the surface soil of the Collinsville soil is very dark grayish brown and dark brown fine sandy loam about 14 inches thick. Bedrock is at a depth of about 14 inches. In some areas the surface layer contains many sandstone rocks.

Included with these soils in mapping are small areas of Bates and Dennis soils. These included soils make up about 10 percent of the map unit. The Bates soils are moderately deep over sandstone. They are on the upper side slopes. The deep Dennis soils are on foot slopes.

Permeability is slow in the Eram soil and moderately rapid in the Collinsville soil. Surface runoff is rapid on both soils. Available water capacity is low in the Eram soil and very low in the Collinsville soil. The root zone is limited to 30 inches in the Eram soil and 14 inches in the Collinsville soil. In the Eram soil a seasonal high water table is perched at a depth of 2 to 3 feet in winter and spring. The shrink-swell potential is high in the Eram soil and low in the Collinsville soil.

Almost all of the acreage is range. These soils generally are unsuitable for cultivation because of a severe hazard of erosion. They are best suited to range. The major concerns in managing range are the hazard of erosion and the low and very low available water capacity. An adequate plant cover and ground mulch reduce the runoff rate, help to prevent excessive soil loss, and increase the moisture supply. Overgrazing destroys the protective plant cover and causes deterioration of the plant community. Under these conditions, the more desirable grasses are replaced by less productive mid and short grasses and by weeds. Proper stocking rates, deferred grazing, and brush control help to keep the range in good condition.

The shrink-swell potential of the Eram soil and the depth to rock in the Collinsville soil are severe limitations on sites for dwellings without basements. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the structural damage caused by the shrinking and swelling of the Eram soil. The deeper, less sloping adjacent soils are better building sites.

These soils generally are unsuitable as septic tank absorption fields because the depth to rock in both soils and the wetness and slow permeability in the Eram soil are severe limitations. The depth to rock and the slope are severe limitations on sites for sewage lagoons. The deeper, less sloping included soils on foot slopes are suitable sites for lagoons.

The shrink-swell potential and low strength of the Eram soil and the depth to rock in the Collinsville soil are severe limitations on sites for local roads and streets. The adverse effects of shrinking and swelling and low strength can be lessened by strengthening or replacing the base material.

The capability subclass is VIe.

Ke—Kenoma silt loam, 1 to 3 percent slopes. This gently sloping, moderately well drained soil is on the tops of ridges in the uplands. Individual areas are irregular in shape and range from 20 to 600 acres in size.

Typically, the surface layer is very dark grayish brown silt loam about 8 inches thick. The subsoil is mottled, very firm silty clay about 42 inches thick. The upper part is dark brown, and the lower part is dark grayish brown. The underlying material to a depth of about 60 inches is light brownish gray, mottled silty clay loam. In some areas the surface layer is dark brown silty clay loam.

Included with this soil in mapping are small areas of the nearly level, somewhat poorly drained Parsons soils on ridgetops. These soils make up 10 to 15 percent of the map unit.

Permeability is very slow in the Kenoma soil, and available water capacity is high. Surface runoff is medium. The content of organic matter is moderate, and natural fertility is medium. The surface layer is friable and can be easily tilled. The shrink-swell potential is high.

About two-thirds of the acreage is cultivated. The rest dominantly is range or pasture. This soil is well suited to grain sorghum, wheat, and soybeans and to grasses and legumes for hay and pasture. Erosion is a hazard, however, if cultivated crops are grown. Also, the soil is droughty in summer because the clayey subsoil absorbs and releases moisture slowly. Minimum tillage, grassed waterways, terraces, and contour farming help to prevent excessive soil loss and conserve moisture. Returning crop residue to the soil increases the content of organic matter and the infiltration rate.

This soil is well suited to range. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates and rotation grazing help to keep the range in good condition.

The shrink-swell potential is a severe limitation if this soil is used as a site for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the structural damage caused by shrinking and swelling. Low strength and the shrink-swell potential are severe limitations on sites for local roads and streets. Strengthening or replacing the base material helps to overcome these limitations.

This soil generally is unsuitable as a septic tank absorption field because the very slow permeability is a severe limitation. Sewage lagoons are a suitable alternative in many areas, but the slope is a moderate limitation. The less sloping included soils are better sites.

The capability subclass is IIIe.

La—Lanton silty clay loam. This nearly level, somewhat poorly drained soil is on flood plains. It is occasionally flooded. Individual areas are long and narrow or irregularly shaped and range from 50 to 400 acres in size.

Typically, the surface layer is very dark grayish brown silty clay loam about 8 inches thick. The subsurface layer is black silty clay loam about 18 inches thick. The next 10 inches is very dark gray, firm silty clay loam. The upper part of the underlying material is very dark gray silty clay loam. The lower part to a depth of about 60 inches is gray silty clay. In some areas the surface layer is silt loam.

Included with this soil in mapping are small areas of Mason and Osage soils. These soils make up 10 to 20 percent of the map unit. The well drained Mason soils are on stream terraces. The poorly drained, clayey Osage soils are on flood plains.

Permeability is moderately slow in the Lanton soil, and available water capacity is high. Surface runoff is slow. The content of organic matter is moderate, and natural fertility is high. The surface layer is friable and can be easily tilled. A seasonal high water table is at a depth of 1 to 2 feet in winter and spring. The shrink-swell potential is moderate.

Almost all areas are cultivated. Some small areas are used as woodland or pasture. This soil is well suited to corn, soybeans, and wheat and to grasses and legumes for hay and pasture. Flooding or ponding delays spring planting in some years. Field drainage ditches help to remove excess surface water. Returning crop residue to the soil increases the content of organic matter and improves tilth.

This soil is well suited to range. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates and deferred grazing improve the condition of the range.

This soil is suited to trees. A few small areas support native hardwoods. Tree seeds, cuttings, and seedlings survive and grow well if competing plants are controlled or removed. Plant competition can be controlled by site preparation or by spraying, cutting, or girdling.

This soil generally is unsuitable as a site for dwellings, local roads and streets, septic tank absorption fields, and sewage lagoons because the flooding is a severe hazard. Overcoming this hazard is difficult without major flood control measures.

The capability subclass is IIw.

Le—Leanna silt loam. This nearly level, poorly drained soil is on low stream terraces. It is occasionally flooded. Individual areas are irregular in shape and range from 10 to 50 acres in size.

Typically, the surface layer is very dark grayish brown silt loam about 6 inches thick. The subsurface layer is dark gray silt loam about 7 inches thick. The subsoil extends to a depth of about 60 inches or more. The upper part is black, mottled, very firm silty clay. The lower part is dark grayish brown, mottled, firm silty clay loam. In some areas the surface layer is dark gray silt loam.

Included with this soil in mapping are small areas of Mason soils. These soils make up about 15 percent of the map unit. They have a silty clay loam surface layer. They are well drained and are on stream terraces adjacent to flood plains.

Permeability is very slow in the Leanna soil, and available water capacity is high. Surface runoff is slow. The content of organic matter is moderate, and natural fertility is high. The surface layer is friable and can be easily tilled. A seasonal high water table is perched at a depth of 0.5 to 2 feet in winter and spring. The shrink-swell potential is high.

Almost all areas are cultivated. This soil is well suited to grain sorghum, wheat, and soybeans and to grasses and legumes for hay and pasture. Flooding or ponding delays spring planting in some years. Field drainage ditches help to remove excess surface water. Returning crop residue to the soil increases the content of organic matter and improves tilth.

This soil is well suited to range. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates and deferred grazing improve the condition of the range.

This soil is suited to trees. A few small areas support native hardwoods. Tree seeds, cuttings, and seedlings survive and grow well if competing plants are controlled or removed. Plant competition can be controlled by site preparation or by spraying, cutting, or girdling.

This soil generally is unsuitable as a site for dwellings, local roads and streets, septic tank absorption fields, and sewage lagoons because the flooding is a severe hazard. Overcoming this hazard is difficult without major flood control measures.

The capability subclass is IIw.

Ma—Mason silt loam. This nearly level, well drained soil is on stream terraces. It is subject to rare flooding. Individual areas are long and narrow and range from 20 to 200 acres in size.

Typically, the surface soil is very dark grayish brown silt loam about 17 inches thick. The subsoil to a depth of about 60 inches is silty clay loam. The upper part is dark brown and firm. The lower part is dark yellowish brown and friable.

Included with this soil in mapping are small areas of the somewhat poorly drained Lanton soils on flood plains. These soils make up about 10 percent of the map unit.

Permeability is moderately slow in the Mason soil, and available water capacity is high. Surface runoff is slow. The content of organic matter is moderate, and natural fertility is high. The surface layer is friable and can be easily tilled. The shrink-swell potential is moderate.

Almost all areas are cultivated. This soil is well suited to corn, wheat, and soybeans and to grasses and legumes for hay and pasture. Returning crop residue to the soil increases the content of organic matter and improves tilth.

This soil is well suited to range. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates and deferred grazing improve the condition of the range.

This soil is suited to trees. A few small areas support native hardwoods. Tree seeds, cuttings, and seedlings survive and grow well if competing plants are controlled or removed. Plant competition can be controlled by site preparation or by spraying, cutting, or girdling.

This soil generally is unsuitable as a site for dwellings because the flooding is a severe hazard. Overcoming this hazard is difficult without major flood control measures. Low strength is a severe limitation on sites for local roads and streets. Strengthening or replacing the base material helps to overcome this limitation.

The moderately slow permeability is a severe limitation if this soil is used as a septic tank absorption field. Increasing the size of the absorption field helps to overcome this limitation. The soil is suitable as a site for sewage lagoons.

The capability class is I.

No—Nowata silt loam, 3 to 5 percent slopes. This moderately sloping, well drained soil is on the tops of ridges in the uplands. Individual areas are irregular in shape and range from 20 to 200 acres in size.

Typically, the surface layer is very dark grayish brown silt loam about 10 inches thick. The subsurface layer is dark brown silt loam about 5 inches thick. The subsoil is firm cherty silty clay loam about 21 inches thick. The upper part is dark brown, and the lower part is brown. Bedrock is at a depth of about 36 inches. In some areas the surface layer is cherty silt loam.

Included with this soil in mapping are small areas of the deep, moderately well drained Kenoma soils on ridgetops. These soils make up about 15 percent of the map unit.

Permeability is moderately slow in the Nowata soil, and available water capacity is low. Surface runoff is

medium. The content of organic matter is moderately low, and natural fertility is medium. The surface layer is friable and can be easily tilled. The root zone is restricted by the bedrock at a depth of about 36 inches. The shrink-swell potential is moderate.

About two-thirds of the acreage is range or pasture. The rest generally is cultivated. This soil is moderately well suited to wheat and grain sorghum and to grasses and legumes for pasture. Erosion is a hazard if cultivated crops are grown. Minimum tillage, contour farming, grassed waterways, and terraces help to prevent excessive soil loss and conserve moisture. Returning crop residue to the soil increases the content of organic matter and the infiltration rate.

This soil is well suited to range. The major concern in managing range is the droughtiness caused by the low available water capacity. An adequate plant cover and ground mulch reduce the runoff rate and increase the available water capacity. Overgrazing reduces the vigor and retards the growth of the grasses and causes deterioration of the plant community. Under these conditions, the more desirable grasses are replaced by less productive mid and short grasses and by weeds. Proper stocking rates, deferred grazing, and brush control help to keep the range in good condition.

The depth to rock and the shrink-swell potential are moderate limitations if this soil is used as a site for dwellings without basements or for local roads and streets. The deeper included soils are better building sites. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the structural damage caused by shrinking and swelling. Strengthening or replacing the base material helps to overcome the shrinking and swelling on sites for local roads and streets.

This soil generally is unsuitable as a septic tank absorption field because the depth to rock and the moderately slow permeability are severe limitations. The depth to rock is a severe limitation on sites for sewage lagoons. The deeper, less sloping included soils on broad ridgetops are suitable sites for lagoons.

The capability subclass is IVe.

Or—Orthents, hilly. These moderately sloping to steep, well drained soils are on uplands. Individual areas range from 5 to 400 acres in size.

In a typical area, soil, shale, and rock are mixed in spoil banks formed by strip mining. All of this material is shaly and loamy. Physical and chemical properties vary.

Included with these soils in mapping are areas of water, bare rocks, and extremely acid shale. These areas make up 5 to 20 percent of the unit.

Almost all areas are wasteland or support trees and shrubs. A few small areas have been smoothed and seeded to pasture grasses. The smoothed areas are more accessible. These soils are moderately well suited to pasture. Applications of lime and fertilizer help to establish and maintain the stand of grasses. Proper stocking rates, rotation grazing, and a timely season of use increase forage production.

These soils are moderately well suited to range. Land smoothing is needed. Range seeding establishes prairie grasses. Proper stocking rates, deferred grazing, and brush control improve the condition of the range.

These soils generally are unsuitable for cultivation and most other uses because of the slope and the rock fragments.

The capability subclass is VIs.

Os—Osage silty clay. This nearly level, poorly drained soil is on flood plains. It is occasionally flooded. Individual areas are long and narrow or irregularly shaped and range from 40 to 500 acres in size.

Typically, the surface soil is black silty clay about 13 inches thick. The subsoil to a depth of about 60 inches is very dark gray and dark gray, very firm silty clay. In some areas the surface layer is silty clay loam.

Included with this soil in mapping are small areas of the somewhat poorly drained Lanton soils. These soils make up about 10 percent of the map unit. They are in the slightly higher, convex areas on the flood plains.

Permeability is very slow in the Osage soil, and available water capacity is high. Surface runoff is very slow. The content of organic matter is moderate, and natural fertility is high. The surface layer is very firm, and tilling is difficult. A seasonal high water table is perched within a depth of 1 foot in winter and spring. The shrink-swell potential is very high.

Almost all of the acreage is cultivated. The rest dominantly is woodland. This soil is moderately well suited to grain sorghum, wheat, and soybeans and to grasses and legumes for hay and pasture. Flooding or ponding delays spring planting in most years. Also, the soil is droughty in the summer because the clayey surface layer and subsoil absorb and release moisture slowly. Field drainage ditches help to remove excess surface water. Returning crop residue to the soil or adding other organic material improves tilth.

This soil is well suited to range. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates and deferred grazing help to keep the range in good condition.

This soil is suited to trees. A few small areas support native hardwoods. Tree seeds, cuttings, and seedlings survive and grow well if competing plants are controlled or removed. Plant competition can be controlled by site preparation or by spraying, cutting, or girdling.

This soil generally is unsuitable as a site for dwellings, local roads and streets, septic tank absorption fields, and sewage lagoons because the flooding is a severe hazard. Overcoming this hazard is difficult without major flood control measures.

The capability subclass is IIIw.

Pa—Parsons silt loam. This nearly level, somewhat poorly drained soil is on broad ridgetops in the uplands.

Individual areas are irregular in shape and range from 40 to 400 acres in size.

Typically, the surface layer is very dark gray silt loam about 7 inches thick. The subsurface layer is dark gray and gray silt loam about 8 inches thick. The subsoil is dark gray, very firm silty clay about 25 inches thick. The underlying material to a depth of about 60 inches is gray silty clay. In some areas the soil has no subsurface layer.

Included with this soil in mapping are small areas of Bates and Catoosa soils on side slopes. These soils make up about 10 percent of the map unit. The Bates soils are moderately deep over sandstone. The Catoosa soils are moderately deep over limestone.

Permeability is very slow in the Parsons soil, and available water capacity is high. Surface runoff is slow. The content of organic matter is low, and natural fertility is medium. A seasonal high water table is perched at a depth of 0.5 to 1.5 feet in winter and spring. The shrink-swell potential is high.

Almost all of the acreage is cultivated. The rest dominantly is range or pasture. This soil is well suited to grain sorghum, wheat, and soybeans and to grasses and legumes for hay and pasture. It is droughty in summer, however, because the clayey subsoil absorbs and releases moisture slowly. In the less sloping areas, water ponds on the surface, and in the more sloping areas, erosion is a hazard. Drainage ditches help to remove excess surface water. Minimum tillage, grassed waterways, terraces, and contour farming help to prevent excessive soil loss. Returning crop residue to the soil increases the content of organic matter and the infiltration rate and improves fertility.

This soil is moderately well suited to range. Overgrazing reduces the vigor and retards the growth of the grasses. Proper stocking rates and rotation grazing help to keep the range in good condition.

The shrink-swell potential and the wetness caused by the seasonal high water table are severe limitations if this soil is used as a site for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the structural damage caused by shrinking and swelling and wetness. The wetness, the shrink-swell potential, and low strength are severe limitations on sites for local roads and streets. Strengthening or replacing the base material and installing a drainage system help to overcome these limitations.

Because the very slow permeability and the wetness are severe limitations, this soil generally is unsuitable as a septic tank absorption field. It is suitable, however, as a site for sewage lagoons.

The capability subclass is IIs.

Pt—Pits, quarries. This map unit occurs as excavated areas from which soil and limestone bedrock have been removed. Individual areas are irregular in shape and generally range from 5 to 15 acres in size. A few are larger than 40 acres.

Typically, the bottom of the pit is level, impervious bedrock and the walls are vertical rock 10 to 20 feet high. Piles of crushed rock and areas of water are common.

These pits generally are unsuited to cultivated crops, range, and most other uses. Some abandoned pits can be developed so that they are suitable as habitat for wildlife.

The capability subclass is VIIIs.

Rc—Ringo-Clareson complex, 9 to 15 percent slopes. These moderately steep soils are on uplands. The moderately well drained Ringo soil generally is steeper than the Clareson soil and is on side slopes. The well drained Clareson soil is on narrow ridgetops. Individual areas are long and narrow or irregularly shaped and range from 25 to 1,000 acres in size. They are 75 to 90 percent Ringo soil and 10 to 25 percent Clareson soil. The two soils occur as areas so small or so intricately mixed that mapping them separately is not practical. In areas of the Clareson soil, limestone rocks 1 to 2 feet in diameter cover 0.1 to 3.0 percent of the surface.

Typically, the Ringo soil has a surface layer of very dark grayish brown silty clay about 10 inches thick. The subsoil is dark grayish brown and grayish brown, very firm and firm, calcareous silty clay about 20 inches thick. Bedrock is at a depth of about 30 inches.

Typically, the Clareson soil has a surface layer of very dark brown stony silty clay loam about 10 inches thick. The subsoil is about 22 inches thick. The upper part is very dark brown, very firm flaggy silty clay loam. The lower part is dark reddish brown, very firm flaggy silty clay. Bedrock is at a depth of about 32 inches.

Included with these soils in mapping are small areas of Catoosa and Zaar soils. These included soils make up about 15 percent of the map unit. The well drained Catoosa soils are on ridgetops. The deep, somewhat poorly drained Zaar soils are on foot slopes.

Permeability is very slow in the Ringo soil and moderately slow in the Clareson soil. Available water capacity is low in both soils. Surface runoff is rapid. The root zone is limited to about 30 inches in the Ringo soil and about 32 inches in Clareson soil. The shrink-swell potential is high in the Ringo soil and moderate in the Clareson soil.

Almost all of the acreage is range. These soils generally are unsuitable for cultivation because of a severe hazard of erosion. They are best suited to range. The major concerns in managing range are the hazard of erosion and the low available water capacity. An adequate plant cover and ground mulch reduce the runoff rate, help to prevent excessive soil loss, and increase the moisture supply. Overgrazing destroys the protective plant cover and causes deterioration of the plant community. Under these conditions, the more

desirable grasses are replaced by less productive mid and short grasses and by weeds. Proper stocking rates, deferred grazing, and brush control help to keep the range in good condition.

The shrink-swell potential of the Ringo soil and the large stones in the Clareson soil are severe limitations on sites for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the structural damage caused by the shrinking and swelling of the Ringo soil. Deeper, less stony soils are better suited than the Clareson soil to building site development.

These soils generally are unsuitable as septic tank absorption fields because the depth to rock and the very slow and moderately slow permeability are severe limitations. Also, the large stones are a severe limitation in the Clareson soil. The depth to rock in both soils, the slope of both soils, and the large stones in the Clareson soil are severe limitations on sites for sewage lagoons. The deeper, less sloping included soils on foot slopes are suitable sites for lagoons.

The shrink-swell potential and low strength of the Ringo soil and the large stones and low strength in the Clareson soil are severe limitations on sites for local roads and streets. Strengthening or replacing the base material helps to overcome the low strength and the shrink-swell potential.

The capability subclass is VIe.

Ta—Tamaha silt loam, 1 to 5 percent slopes. This gently sloping, moderately well drained soil is on foot slopes in the uplands. Individual areas are irregular in shape and range from 20 to 200 acres in size.

Typically, the surface layer is dark grayish brown silt loam about 7 inches thick. The subsoil extends to a depth of about 60 inches or more. The upper part is dark yellowish brown, firm silty clay loam. The next part is yellowish brown, mottled, very firm silty clay. The lower part is yellowish brown, firm silty clay loam. In some areas the surface layer is very dark grayish brown.

Included with this soil in mapping are small areas of Kenoma and Osage soils. These soils make up about 15 percent of the map unit. The Kenoma soils have a very dark grayish brown surface layer. They are on ridgetops. The poorly drained Osage soils are on flood plains.

Permeability is very slow in the Tamaha soil, and available water capacity is high. Surface runoff is medium. The content of organic matter and natural fertility are low. The surface layer is friable and can be easily tilled. A seasonal high water table is perched at a depth of 1 to 2 feet in winter and spring. The shrink-swell potential is high.

Almost all areas are cultivated. This soil is moderately well suited to grain sorghum, wheat, and soybeans and to grasses and legumes for hay and pasture. Erosion is a hazard if cultivated crops are grown. Minimum tillage, grassed waterways, terraces, and contour farming help to prevent excessive soil loss and conserve moisture. Returning crop residue to the soil improves fertility and increases the content of organic matter and the infiltration rate.

This soil is moderately well suited to range. Range seeding establishes the prairie grasses. Proper stocking rates, deferred grazing, and brush control help to keep the range in good condition.

This soil is moderately well suited to trees (fig. 5). Most of the trees are used for firewood or charcoal. Measures that prevent grazing in wooded areas help to keep forest litter on the surface and conserve moisture. Harvesting mature trees, thinning, and planting desirable species improve the woodland.

The shrink-swell potential and the wetness are severe limitations if this soil is used as a site for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the structural damage caused by shrinking and swelling and wetness. The shrink-swell potential and low strength are severe limitations on sites for local roads and streets. Strengthening or replacing the base material helps to overcome these limitations.

This soil generally is unsuitable as a septic tank absorption field because the very slow permeability and the wetness are severe limitations. The slope is a moderate limitation on sites for sewage lagoons. The less sloping areas are the better sites.

The capability subclass is IIIe.

Ve—Verdigris silt loam. This nearly level, well drained soil is on flood plains. It is occasionally flooded. Individual areas are long and narrow and range from 20 to 200 acres in size.

Typically, the surface soil is very dark grayish brown silt loam about 22 inches thick. The next 22 inches is dark brown, friable silt loam. The underlying material to a depth of about 60 inches is dark brown silt loam. In places it is gray silty clay.

Included with this soil in mapping are small areas of Osage soils. These soils make up about 5 percent of the map unit. They are poorly drained and are in slightly concave areas.

Permeability is moderate in the Verdigris soil, and available water capacity is high. Surface runoff is slow. The content of organic matter is moderate, and natural fertility is high. The surface layer is friable and can be easily tilled. The shrink-swell potential is moderate.

Almost all areas are cultivated. This soil is well suited to corn, grain sorghum, and soybeans and to grasses and legumes for hay and pasture. Spring flooding, however, delays planting or wheat harvest in some years. Returning crop residue to the soil increases the content of organic matter and improves tilth.

This soil is well suited to trees. Measures that prevent grazing in wooded areas keep forest litter on the surface and conserve moisture. Harvesting mature trees, thinning, and planting desirable species keep the woodland in good condition.

Figure 5.—A grove on Tamaha silt loam, 1 to 5 percent slopes.

This soil is well suited to range. Range seeding helps to establish the prairie grasses. Proper stocking rates, deferred grazing, and brush control help to keep the range in good condition.

This soil generally is unsuitable as a site for dwellings, local roads and streets, septic tank absorption fields, and sewage lagoons because the flooding is a severe hazard. Overcoming this hazard is difficult without major flood control measures.

The capability subclass is IIw.

Vf—Verdigris silt loam, channeled. This nearly level, well drained soil is on flood plains that are deeply incised by stream channels. It is frequently flooded. Individual areas are long and narrow and range from 10 to 100 acres in size.

Typically, the surface soil is very dark grayish brown silt loam about 20 inches thick. The next 20 inches is

dark brown, friable silt loam. The underlying material to a depth of about 60 inches is dark brown silt loam. In some areas scouring and deposition have modified the color and texture of the surface layer.

Included with this soil in mapping are small areas of Dennis soils. These soils make up about 10 percent of the map unit. They are moderately well drained and are on foot slopes.

Permeability is moderate in the Verdigris soil, and available water capacity is high. Surface runoff is slow. The content of organic matter is moderate, and natural fertility is high. The shrink-swell potential is moderate.

About two-thirds of acreage is woodland. The rest is range. This soil is well suited to woodland. Harvesting mature trees, thinning, and planting desirable species help to keep the woodland in good condition. Measures that prevent grazing in wooded areas keep forest litter on the surface, help to control erosion, and conserve moisture.

This soil is well suited to range. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates and rotation grazing help to keep the range in good condition.

This soil generally is unsuitable as a site for dwellings, local roads and streets, septic tank absorption fields, and sewage lagoons because the flooding is a severe hazard. Overcoming this hazard is difficult without major flood control measures.

The capability subclass is Vw.

Za—Zaar silty clay, 0 to 2 percent slopes. This nearly level, somewhat poorly drained soil is on foot slopes in the uplands. Individual areas are irregular in shape and range from 40 to 500 acres in size.

Typically, the surface soil is black silty clay about 15 inches thick. The subsoil is very firm, mottled silty clay about 33 inches thick. The upper part is black. The lower part is very dark grayish brown and dark grayish brown. The underlying material to a depth of about 60 inches is dark grayish brown, mottled silty clay.

Included with this soil in mapping are small areas of the moderately well drained Kenoma soils on ridgetops. These soils make up about 10 percent of the map unit.

Permeability is very slow in the Zaar soil, and available water capacity is high. Surface runoff is slow. The content of organic matter is moderate, and natural fertility is high. The surface layer is firm, and tilling is difficult. A seasonal high water table is perched at a depth of 1 to 2 feet in winter and spring. The shrink-swell potential is high.

Most areas are cultivated. This soil is well suited to grain sorghum, wheat, and soybeans and to grasses and legumes for hay and pasture. Surface runoff from adjacent soils, however, ponds on this soil in winter and spring. As a result, seepy areas are common. Also, the soil is droughty in summer because the clayey surface soil and subsoil absorb and release moisture slowly. Diversion terraces and grassed waterways control the surface runoff on adjoining soils. Drainage ditches help to remove surface water and reduce the wetness in seepy areas. Minimizing tillage and returning crop residue to the soil improve tilth and increase the infiltration rate.

This soil is well suited to range. Overgrazing, however, reduces the vigor and retards the growth of the grasses. Proper stocking rates and rotation grazing help to keep the range in good condition.

The shrink-swell potential and the wetness are severe limitations if this soil is used as a site for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the structural damage caused by shrinking and swelling and wetness. The shrink-swell potential and low strength are severe limitations on sites for local roads and streets. Strengthening or replacing the base material helps to overcome these limitations.

Because the very slow permeability and the wetness are severe limitations, this soil generally is unsuitable as a septic tank absorption field. It is suitable, however, as a site for sewage lagoons.

The capability subclass is IIIw.

Zb—Zaar silty clay, 2 to 6 percent slopes. This moderately sloping, somewhat poorly drained soil is on foot slopes in the uplands. Individual areas are long and narrow or irregularly shaped and range from 40 to 300 acres in size.

Typically, the surface soil is black silty clay about 15 inches thick. The subsoil is very firm, mottled silty clay about 30 inches thick. The upper part is black. The lower part is dark grayish brown. The underlying material to a depth of about 60 inches is dark grayish brown, mottled silty clay. In some areas bedrock is at a depth of about 50 inches.

Included with this soil in mapping are small areas of the moderately deep Clareson and Ringo soils. These soils make up about 10 percent of the map unit. The Clareson soils have a stony surface layer. They are on ridgetops. The Ringo soils are on the upper side slopes.

Permeability is very slow in the Zaar soil, and available water capacity is high. Surface runoff is medium. The content of organic matter is moderate, and natural fertility is high. The surface layer is firm, and tilling is difficult. A seasonal high water table is perched at a depth of 1 to 2 feet in winter and spring. The shrink-swell potential is high.

About half of the acreage is cultivated. The rest dominantly is range or pasture. This soil is moderately well suited to wheat, grain sorghum, and soybeans and to grasses and legumes for hay and pasture. Erosion is a hazard if cultivated crops are grown. Minimum tillage, grassed waterways, terraces, and contour farming help to prevent excessive soil loss and conserve moisture. Returning crop residue to the soil improves tilth and increases the infiltration rate.

This soil is well suited to range. Range seeding helps to establish the prairie grasses. Proper stocking rates,

deferred grazing, and brush control improve the condition of the range.

The shrink-swell potential and the wetness are severe limitations if this soil is used as a site for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with porous material help to prevent the structural damage caused by shrinking and swelling and wetness. The shrink-swell potential and low strength are severe limitations on sites for local roads and streets. Strengthening or replacing the base material helps to overcome these limitations.

This soil generally is unsuitable as a septic tank absorption field because the very slow permeability and the wetness are severe limitations. The slope is a moderate limitation on sites for sewage lagoons. The less sloping included soils are better sites.

The capability subclass is IIIe.

use and management of the soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland and woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

crops and pasture

Earl J. Bondy, conservation agronomist, Soil Conservation Service, helped prepare this section.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed soil map units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

In 1974, about 33 percent of the farmland in Bourbon County was used for cultivated crops and 19 percent for pasture (*6*). Grain sorghum was grown on about 26 percent of the cropland, soybeans on 23 percent, wheat on 17 percent, alfalfa on 13 percent, corn on 12 percent, and oats, barley, and other crops on 9 percent.

During the period 1945 to 1974, the acreage used for soybeans, grain sorghum, and pasture increased significantly. During the same period, the acreage planted to corn, oats, and barley decreased sharply.

Soil erosion is the major problem on about 80 percent of the cropland in Bourbon County. If the slope is more than 2 percent, erosion is a hazard. It reduces the fertility of soils and results in sedimentation in streams. Fertility is reduced as the surface layer is lost and part of the subsoil is incorporated into a plow layer. Loss of the surface layer is especially damaging on soils that have a loamy surface layer and a clayey subsoil, such as Kenoma and Parsons soils. Measures that control erosion improve fertility and minimize the pollution of streams.

A protective plant cover helps to control erosion by reducing the runoff rate. It also increases the infiltration rate. A cropping system that keeps a plant cover on the surface for extended periods not only helps to control erosion but also preserves the fertility of the soils.

Terraces and diversions reduce the length of slopes, the runoff rate, and the risk of erosion. They are most practical on well drained soils that have uniform, regular slopes.

Contour farming should generally be used in combination with terraces. It is best suited to those soils that have smooth, uniform slopes and are suitable for terracing.

Leaving crop residue on the surface, either through minimum tillage or stubble mulching, increases the infiltration rate and reduces the runoff rate and the hazard of erosion. Minimum tillage and stubble mulching are becoming more common in Bourbon County.

Soil tilth is an important factor in the germination of seeds and in the infiltration of water into the soil. Most of

the soils used for crops have a silt loam surface layer that is moderately dark and moderate to low in content of organic matter. Generally, the soil structure is weak and intense rainfall reduces the infiltration rate and increases the runoff rate. Regularly adding a large amount of crop residue or leaving part of the residue on the surface improves soil structure and helps to prevent surface crusting and excessive erosion. Minimum tillage improves tilth and helps to control erosion in cultivated areas of sloping soils.

Soil drainage is a management need on some soils on flood plains. Unless drained by a system of surface drains or surface bedding, the somewhat poorly drained Lanton and poorly drained Osage soils, for example, are so wet that fertility is reduced.

Information about the design of erosion control practices is available in local offices of the Soil Conservation Service. The latest information about growing crops can be obtained from local offices of the Cooperative Extension Service and the Soil Conservation Service.

yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that insures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils.

land capability classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor does it consider possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have slight limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the

subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability classification of each map unit is given in the section "Detailed soil map units."

rangeland

Leonard J. Jurgens, range conservationist, Soil Conservation Service, helped prepare this section.

About 124,000 acres in Bourbon County is rangeland. This acreage is about 36 percent of the farmland in the county. About 110,000 acres is grazing land, and the rest is native hayland. Tall fescue and other grasses on about 65,000 acres of pasture, crop aftermath, and wheat pasture supplement the forage grown on rangeland. More than two-thirds of the rangeland provides forage for cow-calf enterprises. The rest generally provides forage for stocker-feeder and yearling enterprises. Stock water ponds furnish most of the water for livestock (fig. 6).

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationship between the soils and vegetation and water.

Table 6 shows, for many soils in the survey area, the range site; the total annual production of vegetation in favorable, normal, and unfavorable years; the characteristic vegetation; and the average percentage of each species. Only those soils that are used as or are suited to rangeland are listed. Explanation of the column headings in table 6 follows.

A *range site* is a distinctive kind of rangeland that produces a characteristic natural plant community that differs from natural plant communities on other range sites in kind, amount, and proportion of range plants. The relationship between soils and vegetation was ascertained during this survey; thus, range sites generally can be determined directly from the soil map. Soil properties that affect moisture supply and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table are also important.

Total production is the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It includes all vegetation, whether or not it is

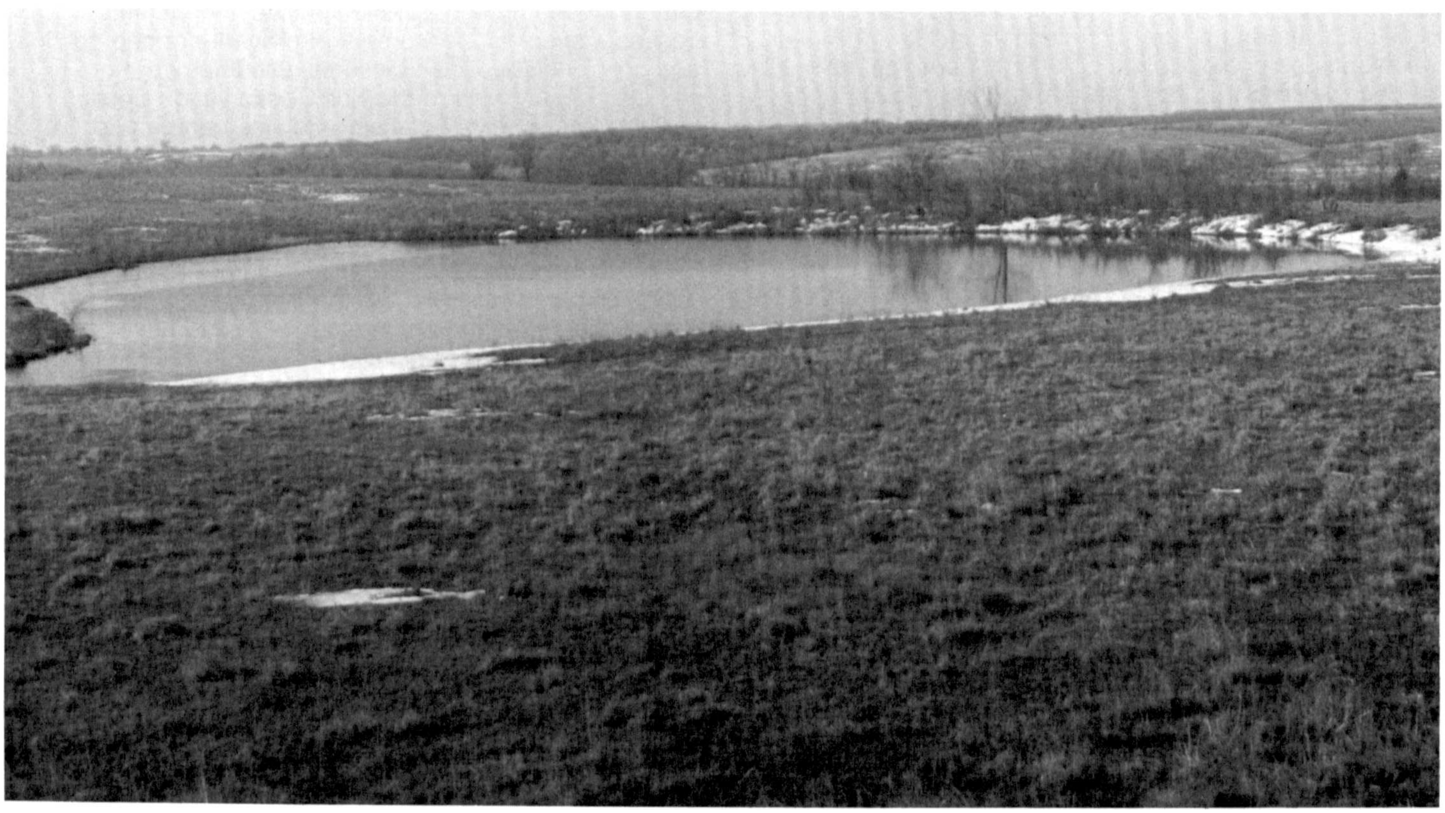


Figure 6.—A stock water pond in an area of Zaar silty clay, 2 to 6 percent slopes.

palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation for favorable, normal, and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In a normal year, growing conditions are about average. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

Dry weight is the total annual yield per acre reduced to a common percent of air-dry moisture.

Characteristic vegetation—the grasses, forbs, and shrubs that make up most of the potential natural plant community on each soil—is listed by common name. Under *composition*, the expected percentage of the total annual production is given for each species making up the characteristic vegetation. The amount that can be used as forage depends on the kinds of grazing animals and on the grazing season.

Range management requires a knowledge of the kinds of soil and of the potential natural plant community. It also requires an evaluation of the present range condition. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. Range condition is an ecological rating only. It does not have a specific meaning that pertains to the present plant community in a given use.

The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the optimum production of vegetation, reduction of the extent of undesirable brush species, conservation of water, and control of erosion and soil blowing. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

The rangeland in Bourbon County generally can be managed so that it is in excellent condition. The soils used as rangeland have an excellent potential for producing a high percentage of quality forage plants. Only about 10 percent of the rangeland, however, produces at an optimum level. On about 10 percent, reseeding is needed before the potential natural plant community can be restored. On more than two-thirds of the rangeland, brush invasion is a serious problem. Measures that remove or control the brush are needed before other management practices can improve the range condition.

More than one-third of the rangeland occurs as areas of Clareson stony silty clay loam, 1 to 4 percent slopes. The stones in this soil reduce the number of measures that can control the brush and restore the potential natural plant community. On all of the rangeland in Bourbon County, however, improved grazing management, prescribed burning, brush control, and reseeding of areas that are in poor condition can restore the potential natural plant community.

woodland management and productivity

Jack J. Rowland, area extension forester, Cooperative Extension Service, helped prepare this section.

According to a forest survey conducted in 1965, about 53,300 acres in Bourbon County is woodland. Of this acreage, 11,000 acres is noncommercial and 42,300 acres is commercial. A small acreage is managed for commercial timber. All of the woodland is privately owned. It generally occurs as irregularly shaped, beltlike tracts along river and creek valleys and drainageways.

Most of the woodland is grazed by livestock. It provides food and cover for many species of wildlife. Many areas are suitable for a variety of recreation uses.

The soils on bottom land along rivers and streams have excellent potential for black walnut, bur oak, pecan, green ash, and other commercial hardwoods. The soils on uplands have poor potential for the trees used for commercial saw logs.

Most of the stands can be improved by thinning out mature trees and undesirable species and planting desirable species. Measures that prevent fire and grazing and control diseases and insects also improve the stands. Local offices of the Soil Conservation Service and the Cooperative Extension Service can help to determine the management needs on specific tracts.

Table 7 can be used by woodland owners or forest managers in planning the use of soils for wood crops. Only those soils suitable for wood crops are listed. The table lists the ordination (woodland suitability) symbol for each soil. Soils assigned the same ordination symbol require the same general management and have about the same potential productivity.

The first part of the *ordination symbol*, a number, indicates the potential productivity of the soils for important trees. The number 1 indicates very high productivity; 2, high; 3, moderately high; 4, moderate; and 5, low. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *x* indicates stoniness or rockiness; *w*, excessive water in or on the soil; *t*, toxic substances in the soil; *d*, restricted root depth; *c*, clay in the upper part of the soil; *s*, sandy texture; *f*, high content of coarse fragments in the soil profile; and *r*, steep slopes. The letter *o* indicates that limitations or restrictions are insignificant. If a soil has more than one limitation, the priority is as follows: x, w, t, d, c, s, f, and r.

In table 7, *slight, moderate,* and *severe* indicate the degree of the major soil limitations to be considered in management.

Ratings of the *erosion hazard* indicate the risk of loss of soil in well managed woodland. The risk is *slight* if the expected soil loss is small, *moderate* if measures are needed to control erosion during logging and road construction, and *severe* if intensive management or special equipment and methods are needed to prevent excessive loss of soil.

Ratings of *equipment limitation* reflect the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. A rating of *slight* indicates that use of equipment is not limited to a particular kind of equipment or time of year; *moderate* indicates a short seasonal limitation or a need for some modification in management or in equipment; and *severe* indicates a seasonal limitation, a need for special equipment or management, or a hazard in the use of equipment.

Seedling mortality ratings indicate the degree to which the soil affects the mortality of tree seedlings. Plant competition is not considered in the ratings. The ratings apply to seedlings from good stock that are properly planted during a period of sufficient rainfall. A rating of *slight* indicates that the expected mortality is less than 25 percent; *moderate*, 25 to 50 percent; and *severe*, more than 50 percent.

Ratings of *plant competition* indicate the degree to which undesirable plants are expected to invade where there are openings in the tree canopy. The invading plants compete with native plants or planted seedlings. A rating of *slight* indicates little or no competition from other plants; *moderate* indicates that plant competition is expected to hinder the development of a fully stocked stand of desirable trees; *severe* indicates that plant competition is expected to prevent the establishment of a desirable stand unless the site is intensively prepared, weeded, or otherwise managed to control undesirable plants.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as a *site index*. This index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The potential productivity is poor if the site index is 40 to 55, fair if 56 to 70, and good if 71 to 85. The site index applies to fully stocked, even-aged, unmanaged stands. Commonly grown trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

Trees to plant are those that are suited to the soils and to commercial wood production.

windbreaks and environmental plantings

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To insure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 8 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 8 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a nursery.

recreation

Robert J. Higgins, biologist, Soil Conservation Service, helped prepare this section.

Bourbon County has several areas of scenic and historic interest. The most important historic site is Fort Scott.

Farm ponds and the Marmaton and Little Osage Rivers provide opportunities for recreation. Several large municipal lakes and Bourbon County State Lake provide the public with opportunities for camping, hunting, fishing, boating, picnicking, and sightseeing. The potential for additional recreational development is fair.

The soils of the survey area are rated in table 9 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 9, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 9 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 12 and interpretations for dwellings without basements and for local roads and streets in table 11.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking, horseback riding, and bicycling should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

wildlife habitat

Robert J. Higgins, biologist, Soil Conservation Service, helped prepare this section.

The primary game species in Bourbon County are bobwhite quail, mourning dove, cottontail, fox squirrel, whitetail deer, and several species of waterfowl. Furbearers are common along the Marmaton and Little Osage Rivers and their tributaries. They are trapped on a limited basis.

Nongame species are numerous because the habitat types are diverse. Cropland, woodland, and grassland are interspersed throughout the county. Each of these habitat types provides a habitat for a different group of species (fig. 7).

The Bourbon County State Lake and other lakes, ponds, and streams provide good to excellent fishing. The species commonly caught are bass, bluegill, crappie, channel cat, bullhead, and flathead catfish.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants. The plants should be those that the soils can support and should be evenly distributed.

In table 10, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, grain sorghum, wheat, oats, and soybeans.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, lovegrass, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these

plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, switchgrass, indiangrass, goldenrod, ragweed, wheatgrass, and native legumes.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, the available water capacity, and wetness. Examples of these plants are oak, cottonwood, black walnut, hackberry, willow, green ash, sycamore, hickory, and mulberry. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive, autumn-olive, plum, fragrant sumac, winterberry, and crabapple.

Coniferous plants furnish browse, seeds, and cones. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of

Figure 7.—A field hedgerow on Catoosa silt loam. The hedgerow provides an excellent habitat for quail.

the root zone, available water capacity, and wetness. Examples of coniferous plants are redcedar, pine, and spruce.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are gooseberry, dogwood, blackberry, buckbrush, and prairie rose.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, cattails, prairie cordgrass, buttonbush, indigobush, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include bobwhite, meadowlark, field sparrow, cottontail, and red fox.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include owls, hawks, thrushes, woodpeckers, squirrels, opossum, groundhogs, raccoon, and whitetail deer.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, redwing blackbirds, muskrat, mink, and beaver.

Habitat for rangeland wildlife consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland include coyotes, jackrabbits, hawks, dickcissels, killdeer, and meadowlarks.

Onsite technical assistance in planning wildlife areas and in determining suitable species of vegetation for planting can be obtained from local offices of the Soil Conservation Service, the Kansas Fish and Game Commission, and the Cooperative Extension Service.

engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

building site development

Table 11 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines (fig. 8), open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding.

Figure 8.—Burying utility lines in Clareson stony silty clay loam, 1 to 4 percent slopes.

The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

sanitary facilities

Table 12 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 12 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to effectively filter the effluent. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 12 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope and

bedrock can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 12 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

construction materials

Table 13 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a probable or improbable source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 13, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

water management

Table 14 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock or to layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of soil blowing or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct

surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of soil blowing, low available water capacity, restricted rooting depth, toxic substances, such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

soil properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics. These results are reported in table 18.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

engineering index properties

Table 15 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil series and their morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as 15 or 20 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (*1*).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as Pt. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The AASHTO classification for soils tested, with group index numbers in parentheses, is given in table 18.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an oven-dry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The

estimates are based on test data from the survey area or from nearby areas and on field examination.

physical and chemical properties

Table 16 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earth-moving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to soil blowing in cultivated areas. The groups indicate the susceptibility to soil blowing and the amount of soil lost. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control soil blowing are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control soil blowing are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to soil blowing.

Organic matter is the plant and animal residue in the soil at various stages of decomposition.

In table 16, the estimated content of organic matter of the plow layer is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

soil and water features

Table 17 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt and water in swamps and marshes are not considered flooding.

Table 17 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered is local information about the extent and levels of flooding and the relation of each soil on

the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 17 are the depth to the seasonal high water table; the kind of water table—that is, perched, artesian, or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 17. Only saturated zones within a depth of about 6 feet are indicated.

An apparent water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. An artesian water table is under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole. A perched water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is specified as either soft or hard. If the rock is soft or fractured, excavations generally can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavations.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low, moderate,* or *high,* is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

engineering index test data

Table 18 shows laboratory test data for several pedons sampled at carefully selected sites in the survey area. The pedons are typical of the series and are described in the section "Soil series and their morphology." The soil samples were tested by the Kansas Department of Transportation.

The testing methods generally are those of the American Association of State Highway and Transportation Officials (AASHTO) or the American Society for Testing and Materials (ASTM).

The tests and methods are: AASHTO classification—M 145 66; Unified classification—D 2487 69 (ASTM); Grain-size distribution—T 88 72 (AASHTO); Liquid limit—T 89 68 (AASHTO); Plasticity index—T 90 70 (AASHTO); and Moisture density, Method A—T 99 74 (AASHTO).

classification of the soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*5*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. In table 19, the soils of the survey area are classified according to the system. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Udoll (*Ud*, meaning humid, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Argiudolls (*Argi*, meaning argillic horizon, plus *udoll*, the suborder of the Mollisols that have a udic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Argiudolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-silty, mixed, thermic Typic Argiudolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the underlying material can differ within a series.

soil series and their morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual* (*4*). Many of the technical terms used in the descriptions are defined in *Soil Taxonomy* (*5*). Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed soil map units."

Bates series

The Bates series consists of moderately deep, well drained, moderately permeable soils on uplands. These soils formed in material weathered from sandstone (fig. 9). Slope ranges from 1 to 7 percent.

Bates soils are similar to Bolivar soils and are commonly adjacent to Collinsville and Kenoma soils. The Bolivar soils lack a mollic epipedon. They are on the lower side slopes. The Collinsville soils are on the upper side slopes. They lack an argillic horizon. Their solum is thinner than that of the Bates soils. The moderately well drained Kenoma soils are on the higher ridgetops.

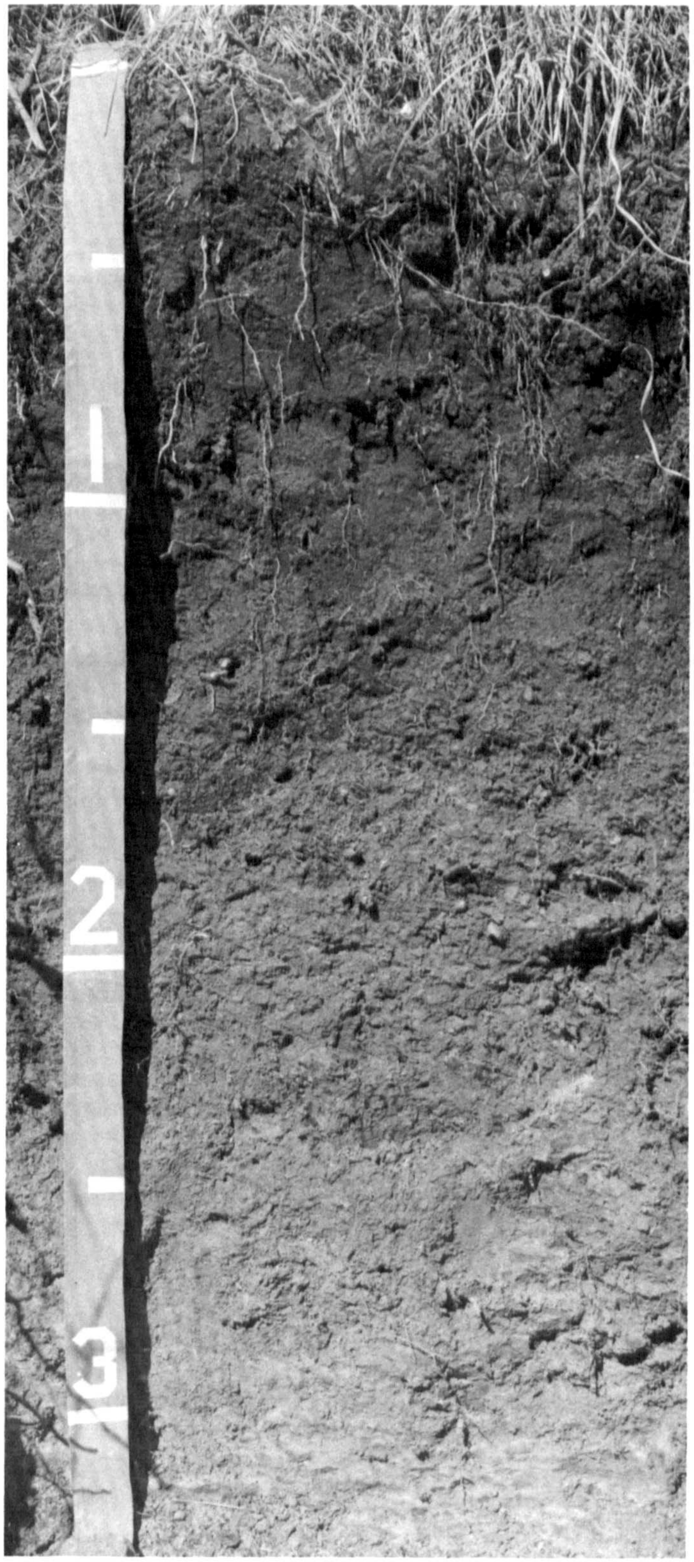


Figure 9.—Profile of Bates loam. Sandstone bedrock is at a depth of about 35 inches. Depth is marked in feet.

Typical pedon of Bates loam, 1 to 4 percent slopes, 100 feet south and 35 feet west of the northeast corner of sec. 10, T. 27 S., R. 23 E.

A1—0 to 12 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; slightly hard, friable; medium acid; clear smooth boundary.
B1—12 to 20 inches; dark brown (10YR 3/3) loam, dark brown (10YR 4/3) dry; moderate medium granular structure; slightly hard, friable; strongly acid; gradual smooth boundary.
B2t—20 to 28 inches; dark brown (7.5YR 4/4) sandy clay loam, brown (7.5YR 5/4) dry; few fine faint yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; hard, firm; strongly acid; gradual smooth boundary.
B3—28 to 35 inches; strong brown (7.5YR 5/6) sandy loam, reddish yellow (7.5YR 6/6) dry; weak medium subangular blocky structure; hard, firm; about 20 percent sandstone fragments, by volume; strongly acid; clear smooth boundary.
Cr—35 inches; sandstone.

The thickness of the solum ranges from 20 to 40 inches and is the same as the depth to sandstone. The mollic epipedon ranges from 8 to 24 inches in thickness. Reaction throughout the profile ranges from strongly acid to slightly acid.

The A1 horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 2 or 3. It is dominantly loam, but the range includes silt loam and fine sandy loam. The B2t horizon has hue of 7.5YR, value of 3 to 5 (4 to 6 dry), and chroma of 3 to 6. It is sandy clay loam, loam, or clay loam.

The map unit Bates loam, 4 to 7 percent slopes, eroded, is a taxadjunct to the Bates series because it lacks a mollic epipedon. This difference, however, does not affect the use or behavior of the soil.

Bolivar series

The Bolivar series consists of moderately deep, well drained, moderately permeable soils on uplands. These soils formed in material weathered from sandstone. Slope ranges from 5 to 15 percent.

Bolivar soils are similar to Bates and Hector soils and are commonly adjacent to Dennis and Hector soils. The Bates soils have a mollic epipedon. They are on ridgetops. The shallow Hector soils lack an argillic horizon. They are on the upper side slopes. The moderately well drained Dennis soils are on foot slopes.

Typical pedon of Bolivar fine sandy loam, in an area of Bolivar-Hector fine sandy loams, 5 to 15 percent slopes, 1,640 feet south and 1,000 feet west of the northeast corner of sec. 14, T. 26 S., R. 25 E.

A1—0 to 5 inches; very dark grayish brown (10YR 3/2) fine sandy loam, dark grayish brown (10YR 4/2) dry;

weak fine granular structure; slightly hard, very friable; medium acid; clear smooth boundary.

A2—5 to 12 inches; dark brown (10YR 4/3) fine sandy loam, brown (10YR 5/3) dry; weak very fine granular structure; slightly hard, very friable; medium acid; clear smooth boundary.

B1—12 to 17 inches; dark brown (10YR 4/3) loam, brown (10YR 5/3) dry; common medium distinct strong brown (7.5YR 5/6) mottles; weak fine subangular blocky structure; hard, friable; about 2 percent sandstone fragments; strongly acid; gradual smooth boundary.

B2t—17 to 26 inches; brown (7.5YR 5/4) sandy clay loam, light brown (7.5YR 6/4) dry; common medium faint strong brown (7.5YR 5/6) mottles; weak fine subangular blocky structure; hard, friable; about 5 percent, by volume, sandstone fragments ranging from 1 to 3 inches in diameter; strongly acid; gradual smooth boundary.

B3—26 to 34 inches; mixed dark grayish brown (10YR 4/2) and strong brown (7.5YR 4/6) loam; weak fine subangular blocky structure; hard, friable; about 5 percent, by volume, fragments of weathered sandstone ranging from 1 to 6 inches in diameter; strongly acid; clear smooth boundary.

Cr—34 inches; weathered sandstone.

The thickness of the solum ranges from 20 to 40 inches and is the same as the depth to bedrock. The content of sandstone fragments is, by volume, less than 10 percent in the B horizon.

The A1 horizon has hue of 10YR, value of 3 (4 dry), and chroma of 2 or 3. It is dominantly fine sandy loam but in some pedons is loam. It is strongly acid or medium acid. The A2 horizon has hue of 10YR, value of 4 or 5 (5 or 6 dry), and chroma of 3 or 4. It is fine sandy loam or loam. The B2t horizon has hue of 5YR or 7.5YR, value of 4 or 5 (5 to 7 dry), and chroma of 4 to 6. It is sandy clay loam, loam, or clay loam. It ranges from very strongly acid to medium acid.

Catoosa series

The Catoosa series consists of moderately deep, well drained, moderately permeable soils on uplands. These soils formed in material weathered from limestone. Slope ranges from 0 to 2 percent.

Catoosa soils are similar to Nowata soils and are commonly adjacent to Clareson and Kenoma soils. The Nowata soils have a cherty B horizon. They are on ridgetops. The Clareson and Kenoma soils also are on ridgetops. The Clareson soils have a stony silty clay loam A horizon and a flaggy silty clay B horizon. The deep Kenoma soils are moderately well drained.

Typical pedon of Catoosa silt loam, 150 feet south and 2,620 feet east of the northwest corner of sec. 34, T. 25 S., R. 25 E.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; slightly hard, friable; slightly acid; abrupt smooth boundary.

A12—8 to 14 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; strong fine granular structure; slightly hard, friable; slightly acid; clear smooth boundary.

B1—14 to 20 inches; dark brown (7.5YR 3/2) silty clay loam, dark brown (10YR 4/3) dry; strong medium granular structure; slightly hard, friable; medium acid; gradual smooth boundary.

B2t—20 to 30 inches; reddish brown (5YR 4/3) silty clay loam, reddish brown (5YR 5/3) dry; few fine distinct red (2.5YR 5/6) mottles; moderate medium subangular blocky structure; hard, firm; few fine black concretions; medium acid; gradual smooth boundary.

B3—30 to 36 inches; dark brown (7.5YR 4/4) silty clay loam, brown (7.5YR 5/4) dry; weak coarse subangular blocky structure; hard, firm; few fine black concretions; about 10 percent limestone fragments, by volume; medium acid; abrupt irregular boundary.

R—36 inches; limestone.

The thickness of the solum, or the depth to bedrock, ranges from 20 to 40 inches. The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 2 or 3. It slightly acid or medium acid. The B2 horizon has hue of 2.5YR to 7.5YR, value of 3 or 4 (4 or 5 dry), and chroma of 3 to 6. It ranges from strongly acid to neutral.

Clareson series

The Clareson series consists of moderately deep, well drained, moderately slowly permeable soils on uplands. These soils formed in material weathered from limestone (fig. 10). Slope ranges from 1 to 12 percent.

Clareson soils are similar to Nowata soils and are commonly adjacent to Catoosa, Nowata, and Ringo soils. The Catoosa and Nowata soils are on ridgetops. The Nowata soils have a loamy-skeletal subsoil. The Catoosa soils have a fine-silty subsoil in which the content of coarse fragments is less than 10 percent. The clayey Ringo soils lack an argillic horizon. They are on the lower side slopes.

Typical pedon of Clareson stony silty clay loam, 1 to 4 percent slopes, 1,960 feet north and 1,000 feet west of the southeast corner of sec. 8, T. 26 S., R. 22 E.

A1—0 to 10 inches; very dark brown (10YR 2/2) stony silty clay loam, very dark grayish brown (10YR 3/2) dry; strong fine granular structure; hard, firm; neutral; clear smooth boundary.

B1—10 to 15 inches; very dark brown (7.5YR 2/2) flaggy silty clay loam, dark brown (7.5YR 3/2) dry; strong medium granular structure; very hard, very firm; about 50 percent limestone fragments, by volume; medium acid; gradual smooth boundary.

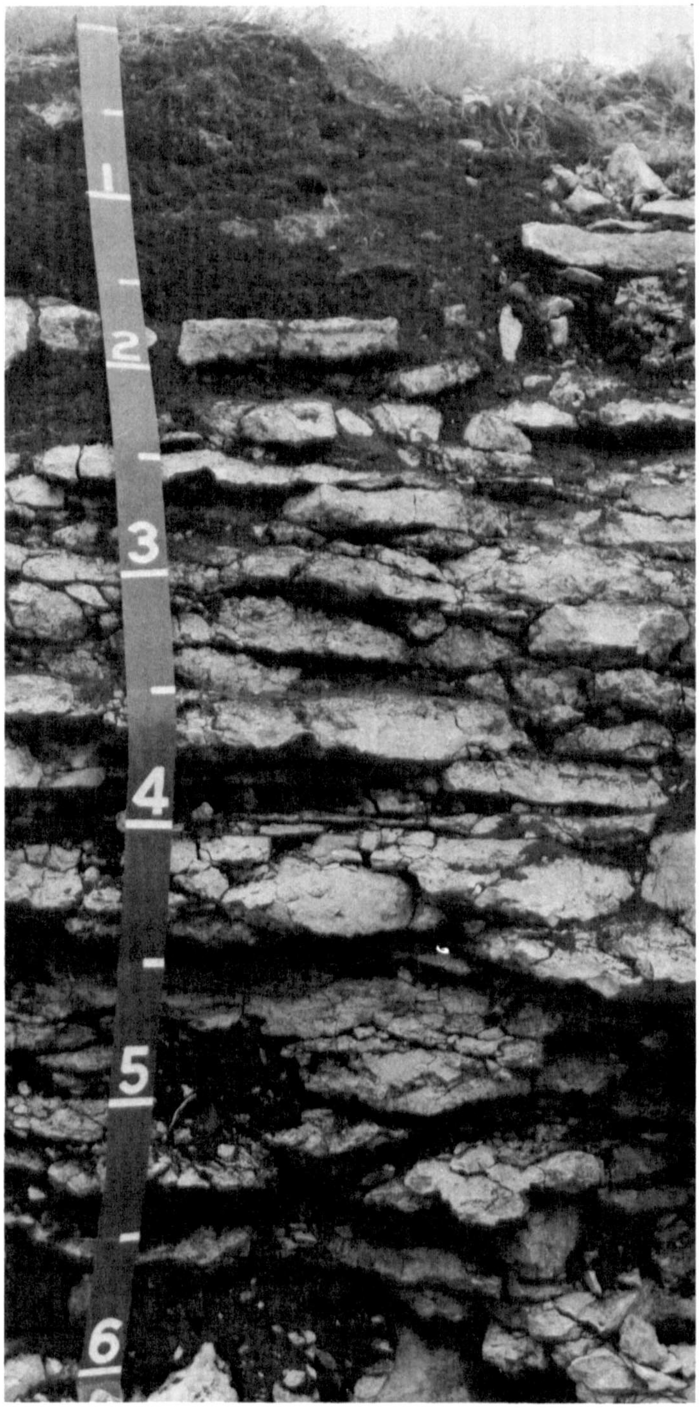


Figure 10.—Profile of Clareson stony silty clay loam. Limestone bedrock is at a depth of about 32 inches. Depth is marked in feet.

B2t—15 to 25 inches; dark reddish brown (5YR 3/3) flaggy silty clay, dark reddish gray (5YR 4/2) dry; strong fine subangular blocky structure; very hard, very firm; about 65 percent flaggy and smaller limestone fragments, by volume; few fine black concretions; slightly acid; gradual smooth boundary.

B3—25 to 32 inches; dark reddish brown (5YR 3/3) flaggy silty clay, reddish gray (5YR 5/2) dry; moderate medium subangular blocky structure; very hard, very firm; about 75 percent flaggy limestone fragments, by volume; few fine black concretions; neutral; abrupt wavy boundary.

R—32 inches; limestone.

The thickness of the solum, or the depth to bedrock, ranges from 20 to 40 inches. In the A1 horizon the content of stony limestone fragments ranges, by volume, from 25 to 65 percent. In the B horizon the content of flaggy fragments ranges, by volume, from 50 to 85 percent.

The A1 and B1 horizons have hue of 7.5YR or 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 2 or 3. They are dominantly stony silty clay loam, but the range includes silty clay loam and flaggy silty clay loam. The A and B horizons range from medium acid to neutral. The B2t horizon has hue of 2.5YR to 7.5YR, value of 3 or 4 (4 or 5 dry), and chroma of 3 to 6. It is flaggy silty clay or flaggy silty clay loam.

Collinsville series

The Collinsville series consists of shallow, well drained, moderately rapidly permeable soils on uplands. These soils formed in material weathered from sandstone. Slope ranges from 5 to 12 percent.

Collinsville soils are similar to Hector soils and are commonly adjacent to Bates and Eram soils. The Hector soils lack a mollic epipedon. They are on the upper side slopes. The Bates soils have a subsoil and are 20 to 40 inches deep over sandstone. They are on ridgetops. The Eram soils have a clayey subsoil and are 20 to 40 inches deep over shale. They are on the lower side slopes.

Typical pedon of Collinsville fine sandy loam, in an area of Eram-Collinsville complex, 5 to 12 percent slopes, 1,300 feet north and 2,140 feet east of the southwest corner of sec. 27, T. 26 S., R. 25 E.

A11—0 to 7 inches; very dark grayish brown (10YR 3/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; moderate medium granular structure; slightly hard, very friable; about 5 percent, by volume, sandstone fragments less than 3 inches in diameter; slightly acid; clear smooth boundary.

A12—7 to 14 inches; dark brown (7.5YR 3/2) fine sandy loam, brown (7.5YR 5/2) dry; weak fine granular structure; slightly hard, very friable; about 10 percent, by volume, sandstone fragments ranging from 1 to 6 inches in diameter; strongly acid; abrupt smooth boundary.

R—14 inches; sandstone.

The thickness of the solum, or the depth to sandstone, ranges from 10 to 20 inches. The solum ranges from strongly acid to slightly acid. The content of sandstone fragments ranges, by volume, from 0 to 5 percent in the A11 horizon and from 3 to 35 percent in the A12 horizon.

The A horizon has hue of 7.5YR or 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 2 or 3. It is dominantly fine sandy loam, but the range includes loam.

Dennis series

The Dennis series consists of deep, moderately well drained, slowly permeable soils on foot slopes in the uplands. These soils formed in material weathered from shale. Slope ranges from 1 to 6 percent.

Dennis soils are similar to Kenoma and Tamaha soils and are commonly adjacent to Eram and Verdigris soils. The Kenoma soils lack a B1 horizon. They are on ridgetops. The Tamaha soils lack a mollic epipedon. They are on foot slopes. The Eram soils have shale bedrock at a depth of 20 to 40 inches. They are on the lower side slopes. The fine-silty Verdigris soils lack an argillic horizon. They are on flood plains.

Typical pedon of Dennis silt loam, 3 to 6 percent slopes, 200 feet east and 30 feet north of the southwest corner of sec. 19, T. 27 S., R. 24 E.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; slightly hard, friable; medium acid; abrupt smooth boundary.

A12—8 to 15 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; slightly hard, friable; grayish coatings on faces of some peds in the lower part; medium acid; clear smooth boundary.

B1—15 to 22 inches; dark brown (10YR 3/3) silty clay loam, dark brown (10YR 4/3) dry; common fine faint dark yellowish brown (10YR 4/4) mottles; moderate medium subangular blocky structure; hard, firm; dark organic matter stains on faces of some peds; strongly acid; gradual smooth boundary.

B21t—22 to 28 inches; dark brown (10YR 4/3) silty clay, grayish brown (10YR 5/2) dry; common medium distinct yellowish brown (10YR 5/6) mottles; moderate fine blocky structure; very hard, very firm; few fine black concretions; few dark organic matter stains on faces of some peds; strongly acid; gradual smooth boundary.

B22t—28 to 35 inches; dark grayish brown (10YR 4/2) silty clay, grayish brown (10YR 5/2) dry; common medium distinct yellowish brown (10YR 5/6) mottles; moderate medium blocky structure; very hard, very firm; few fine black concretions; strongly acid; gradual smooth boundary.

B31—35 to 48 inches; dark grayish brown (10YR 4/2) silty clay, grayish brown (10YR 5/2) dry; common medium distinct yellowish brown (10YR 5/6) mottles; weak coarse blocky structure; very hard, very firm; few fine black and noncalcareous white concretions; medium acid; gradual smooth boundary.

B32—48 to 60 inches; yellowish brown (10YR 5/6) silty clay loam, brownish yellow (10YR 6/6) dry; many medium distinct gray (10YR 6/1) mottles; weak coarse blocky structure; very hard, very firm; few fine black concretions; slightly acid.

The solum is more than 60 inches thick. The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 2. It is dominantly silt loam but in some pedons is loam. It is medium acid or strongly acid. The B2t horizon has hue of 7.5YR or 10YR, value of 4 or 5 (5 or 6 dry), and chroma of 2 to 6. It is silty clay or silty clay loam that ranges from 35 to 50 percent clay. It ranges from strongly acid to slightly acid.

Eram series

The Eram series consists of moderately deep, moderately well drained, slowly permeable soils on uplands. These soils formed in material weathered from shale. Slope ranges from 5 to 12 percent.

Eram soils are similar to Ringo soils and are commonly adjacent to Collinsville and Dennis soils. The Ringo soils lack an argillic horizon. They are on the lower side slopes. The Collinsville soils have bedrock within a depth of 20 inches and lack an argillic horizon. They are on ridgetops. The Dennis soils are more than 60 inches deep. They are on foot slopes.

Typical pedon of Eram silty clay loam, in an area of Eram-Collinsville complex, 5 to 12 percent slopes, 1,200 feet north and 2,340 feet east of the southwest corner of sec. 27, T. 26 S., R. 25 E.

A1—0 to 10 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; hard, firm; medium acid; gradual smooth boundary.

B2t—10 to 20 inches; dark grayish brown (10YR 4/2) silty clay, brown (10YR 5/3) dry; common fine distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; very hard, very firm; medium acid; gradual smooth boundary.

B3—20 to 30 inches; mixed dark brown (10YR 4/3), grayish brown (10YR 5/2), and very dark grayish brown (10YR 3/2) silty clay; weak medium subangular blocky structure; very hard, very firm; few lenses of unweathered shale in the lower part; slightly acid; gradual smooth boundary.

Cr—30 inches; shale.

The thickness of the solum, or the depth to shale, ranges from 20 to 40 inches. The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 2 or 3.

It is dominantly silty clay loam but in some pedons is clay loam or silt loam. It is medium acid or slightly acid. The B2t horizon has hue of 7.5YR or 10YR, value of 4 or 5 (5 or 6 dry), and chroma of 2 to 4. It is silty clay or silty clay loam. It ranges from strongly acid to neutral.

Hector series

The Hector series consists of shallow, well drained, moderately rapidly permeable soils on uplands. These soils formed in material weathered from sandstone. Slope ranges from 5 to 15 percent.

Hector soils are similar to Bolivar and Collinsville soils and are commonly adjacent to Bolivar and Kenoma soils. The moderately deep Bolivar soils have an argillic horizon. They are on the lower side slopes. The Collinsville soils have a mollic epipedon. The deep, moderately well drained Kenoma soils are on ridgetops.

Typical pedon of Hector fine sandy loam, in an area of Bolivar-Hector fine sandy loams, 5 to 15 percent slopes, 1,160 feet south and 1,720 feet west of the northeast corner of sec. 20, T. 27 S., R. 25 E.

O1—2 inches to 0; partly decomposed tree leaves, twigs, and other vegetative matter.

A1—0 to 3 inches; dark brown (10YR 3/3) fine sandy loam, brown (10YR 5/3) dry; weak fine granular structure; slightly hard, very friable; medium acid; clear smooth boundary.

A2—3 to 7 inches; brown (10YR 5/3) fine sandy loam, light yellowish brown (10YR 6/4) dry; weak medium granular structure; slightly hard, very friable; strongly acid; clear smooth boundary.

B2—7 to 12 inches; brown (7.5YR 5/4) fine sandy loam, light brown (7.5YR 6/4) dry; weak medium subangular blocky structure parting to weak fine granular; hard, very friable; about 10 percent, by volume, sandstone fragments less than 3 inches in diameter; strongly acid; abrupt smooth boundary.

R—12 inches; sandstone.

The thickness of the solum, or the depth to bedrock, ranges from 10 to 20 inches. The content of sandstone fragments is, by volume, less than 15 percent in the B2 horizon.

The A1 horizon has hue of 10YR, value of 3 or 4 (4 or 5 dry), and chroma of 2 or 3. It is dominantly fine sandy loam but in some pedons is loam. It ranges from strongly acid to slightly acid. The A2 horizon has hue of 10YR, value of 4 or 5 (5 or 6 dry), and chroma of 2 to 4. It is fine sandy loam or loam. The B2 horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 4 to 6. It is fine sandy loam or sandy loam. It is very strongly acid or strongly acid.

Kenoma series

The Kenoma series consists of deep, moderately well drained, very slowly permeable soils on uplands. These soils formed in old alluvial sediments and in material weathered from shale. Slope ranges from 1 to 3 percent.

Kenoma soils are similar to Dennis soils and are commonly adjacent to Bates, Catoosa, and Parsons soils. The Dennis soils have a B1 horizon. They are on foot slopes. The Bates and Catoosa soils are on ridgetops. The Bates soils are 20 to 40 inches deep over sandstone bedrock, and the Catoosa soils are 20 to 40 inches deep over limestone bedrock. The Parsons soils have an A2 horizon. They are on broad ridgetops.

Typical pedon of Kenoma silt loam, 1 to 3 percent slopes, 550 feet east and 30 feet north of the southwest corner of sec. 10, T. 25 S., R. 23 E.

A1—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, gray (10YR 5/1) dry; moderate fine granular structure; slightly hard, friable; medium acid; abrupt smooth boundary.

B21t—8 to 24 inches; dark brown (10YR 3/3) silty clay, dark grayish brown (10YR 4/2) dry; few fine distinct dark yellowish brown (10YR 4/4) mottles; moderate medium blocky structure; very hard, very firm; few fine black concretions; slightly acid; gradual smooth boundary.

B22t—24 to 38 inches; dark brown (10YR 4/3) silty clay, grayish brown (10YR 5/2) dry; common fine distinct dark yellowish brown (10YR 4/6) mottles; weak medium blocky structure; very hard, very firm; few gray silt coatings on faces of peds; few fine black concretions; slightly acid; gradual smooth boundary.

B3—38 to 50 inches; dark grayish brown (10YR 4/2) silty clay, brown (10YR 5/3) dry; common fine distinct yellowish brown (10YR 5/6) and gray (10YR 5/1) mottles; weak coarse blocky structure; very hard, very firm; few fine black concretions and few fine lime concretions; mildly alkaline; diffuse smooth boundary.

C—50 to 60 inches; light brownish gray (10YR 6/2) silty clay loam, light gray (10YR 7/2) dry; common medium distinct yellowish brown (10YR 5/6) mottles; massive; hard, firm; about 5 percent shale fragments, by volume; mildly alkaline.

The thickness of the solum ranges from 40 to 60 inches. The mollic epipedon ranges from 20 to 32 inches in thickness and extends into the B2t horizon. The boundary between the A1 and Bt horizons is abrupt or clear. In some pedons grayish coatings are on the faces of peds in the lower part of the A1 horizon and the upper part of the B21t horizon.

The A1 horizon has hue of 10YR, value of 2 or 3 (4 or 5 dry), and chroma of 2. It is dominantly silt loam but in some pedons is silty clay loam. It is strongly acid to slightly acid. The B2t horizon has hue of 10YR, value of 2 to 4 (3 to 6 dry), and chroma of 2 to 4. It is silty clay or silty clay loam; it averages as low as 35 percent clay in some pedons and as high as 50 percent clay in others. It ranges from slightly acid to mildly alkaline.

Lanton series

The Lanton series consists of deep, somewhat poorly drained, moderately slowly permeable soils on flood plains. These soils formed in alluvial sediments. Slope ranges from 0 to 2 percent.

Lanton soils are similar to Leanna and Verdigris soils and are commonly adjacent to Mason and Osage soils. The Leanna soils have a clayey argillic horizon and an albic horizon. They are on stream terraces. The well drained Verdigris soils are on flood plains. The well drained Mason soils are on stream terraces. They have an argillic horizon. The poorly drained, clayey Osage soils are on flood plains.

Typical pedon of Lanton silty clay loam, 720 feet south and 30 feet west of the northeast corner of sec. 35, T. 25 S., R. 24 E.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; few medium faint dark yellowish brown (10YR 4/4) mottles; weak medium granular structure; slightly hard, friable; slightly acid; abrupt smooth boundary.

A12—8 to 16 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; few fine distinct dark yellowish brown (10YR 4/4) mottles; weak fine granular structure; hard, firm; slightly acid; clear smooth boundary.

A13—16 to 26 inches; black (10YR 2/1) silty clay loam, very dark grayish brown (10YR 3/2) dry; few fine distinct dark yellowish brown (10YR 4/4) mottles; weak fine subangular blocky structure; hard, firm; slightly acid; gradual smooth boundary.

ACg—26 to 36 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; common medium distinct dark yellowish brown (10YR 4/4) mottles; weak medium subangular blocky structure; hard, firm; slightly acid; gradual smooth boundary.

C1g—36 to 48 inches; very dark gray (10YR 4/1) silty clay loam, gray (10YR 5/1) dry; many coarse distinct yellowish brown (10YR 5/6) mottles; weak coarse subangular blocky structure; very hard, very firm; slightly acid; gradual smooth boundary.

C2g—48 to 60 inches; gray (10YR 5/1) silty clay, gray (10YR 6/1) dry; many medium distinct yellowish brown (10YR 5/6) mottles; weak coarse subangular blocky structure; very hard, very firm; few fine black concretions; neutral.

The thickness of the solum ranges from 30 to 60 inches or more. The thickness of the mollic epipedon ranges from 24.to 40 inches. The A and C horizons are slightly acid or neutral.

The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 1 or 2. It is dominantly silty clay loam, but the range includes silt loam. The Cg horizon has hue of 10YR or 2.5Y, value of 4 or 5 (4 to 6 dry), and chroma of 1. It is silty clay loam or silty clay.

Leanna series

The Leanna series consists of deep, poorly drained, very slowly permeable soils on stream terraces. These soils formed in silty and clayey alluvial sediments. Slope is 0 to 1 percent.

Leanna soils are similar to Lanton and Parsons soils and are commonly adjacent to Lanton and Mason soils. The Lanton soils are on flood plains. Their subsoil is less clayey than that of the Leanna soils. The Parsons soils have a mollic epipedon that is less than 10 inches thick. They are on uplands. The well drained Mason soils are on stream terraces adjacent to the flood plain.

Typical pedon of Leanna silt loam, 500 feet north and 400 feet west of the southeast corner of sec. 33, T. 23 S., R. 23 E.

Ap—0 to 6 inches; very dark grayish brown (10YR 3/2) silt loam, gray (10YR 5/1) dry; weak fine granular structure; slightly hard, friable; medium acid; abrupt smooth boundary.

A2—6 to 13 inches; dark gray (10YR 4/1) silt loam, gray (10YR 6/1) dry; weak very fine granular structure; slightly hard, friable; strongly acid; clear wavy boundary.

B2t—13 to 38 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; few fine distinct dark yellowish brown (10YR 4/4) mottles; moderate medium blocky structure; very hard, very firm; gray silt particles in cracks and root channels; medium acid; gradual smooth boundary.

B3—38 to 60 inches; dark grayish brown (10YR 4/2) silty clay loam, grayish brown (10YR 5/2) dry; common medium distinct yellowish brown (10YR 5/4) mottles; weak coarse subangular blocky structure; hard, firm; neutral.

The thickness of the solum ranges from 40 to 60 inches or more. The mollic epipedon ranges from 24 to 40 inches in thickness and extends into the B2t horizon.

The Ap or A1 horizon has hue of 10YR, value of 2 or 3 (4 or 5 dry), and chroma of 1 or 2. It is dominantly silt loam but in some pedons is silty clay loam. It ranges from strongly acid to slightly acid. The A2 horizon has hue of 10YR, value of 4 or 5 (5 to 7 dry), and chroma of 1. It ranges from strongly acid to slightly acid. The B2t horizon has hue of 10YR, value of 2 or 3 (4 or 5 dry), and chroma of 1. It is silty clay or silty clay loam that ranges from 35 to 45 percent clay. It is medium acid or slightly acid.

Mason series

The Mason series consists of deep, well drained, moderately slowly permeable soils on stream terraces. These soils formed in silty alluvial sediments. Slope is 0 to 1 percent.

Mason soils are similar to Verdigris soils and are commonly adjacent to Lanton and Verdigris soils. The

well drained Verdigris and somewhat poorly drained Lanton soils are on flood plains. They lack an argillic horizon.

Typical pedon of Mason silt loam, 1,320 feet north and 300 feet west of the southeast corner of sec. 33, T. 23 S., R. 23 E.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; slightly hard, friable; slightly acid; abrupt smooth boundary.

A12—8 to 17 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate medium granular structure; slightly hard, friable; slightly acid; gradual smooth boundary.

B2t—17 to 40 inches; dark brown (10YR 3/3) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate medium subangular blocky structure; hard, firm; slightly acid; gradual smooth boundary.

B3—40 to 60 inches; dark yellowish brown (10YR 4/4) silty clay loam, brown (10YR 5/3) dry; weak coarse subangular blocky structure; slightly hard, friable; medium acid.

The thickness of the solum ranges from 40 to 60 inches or more. The mollic epipedon is more than 20 inches thick.

The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 2 or 3. It is dominantly silt loam but in some pedons is loam. It is medium acid or slightly acid. The B2t horizon has hue of 7.5YR or 10YR, value of 3 or 4 (4 to 6 dry), and chroma of 2 to 4. It is silty clay loam or silt loam that ranges from 25 to 35 percent clay. It ranges from strongly acid to slightly acid.

Nowata series

The Nowata series consists of moderately deep, well drained, moderately slowly permeable soils on uplands. These soils formed in material weathered from cherty limestone (fig. 11). Slope ranges from 3 to 5 percent.

Nowata soils are similar to Catoosa and Clareson soils and are commonly adjacent to Clareson and Kenoma soils. The Catoosa soils contain fewer chert fragments than the Nowata soils. They are in positions on the landscape similar to those of the Nowata soils. The Clareson soils are on the lower side slopes. Their subsoil is more clayey than that of the Nowata soils. The deep, moderately well drained Kenoma soils are on ridgetops.

Typical pedon of Nowata silt loam, 3 to 5 percent slopes, 1,350 feet south and 920 feet east of the northwest corner of sec. 23, T. 27 S., R. 21 E.

A1—0 to 10 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate fine granular structure; hard, friable; about 10 percent chert fragments, by volume; medium acid; gradual smooth boundary.

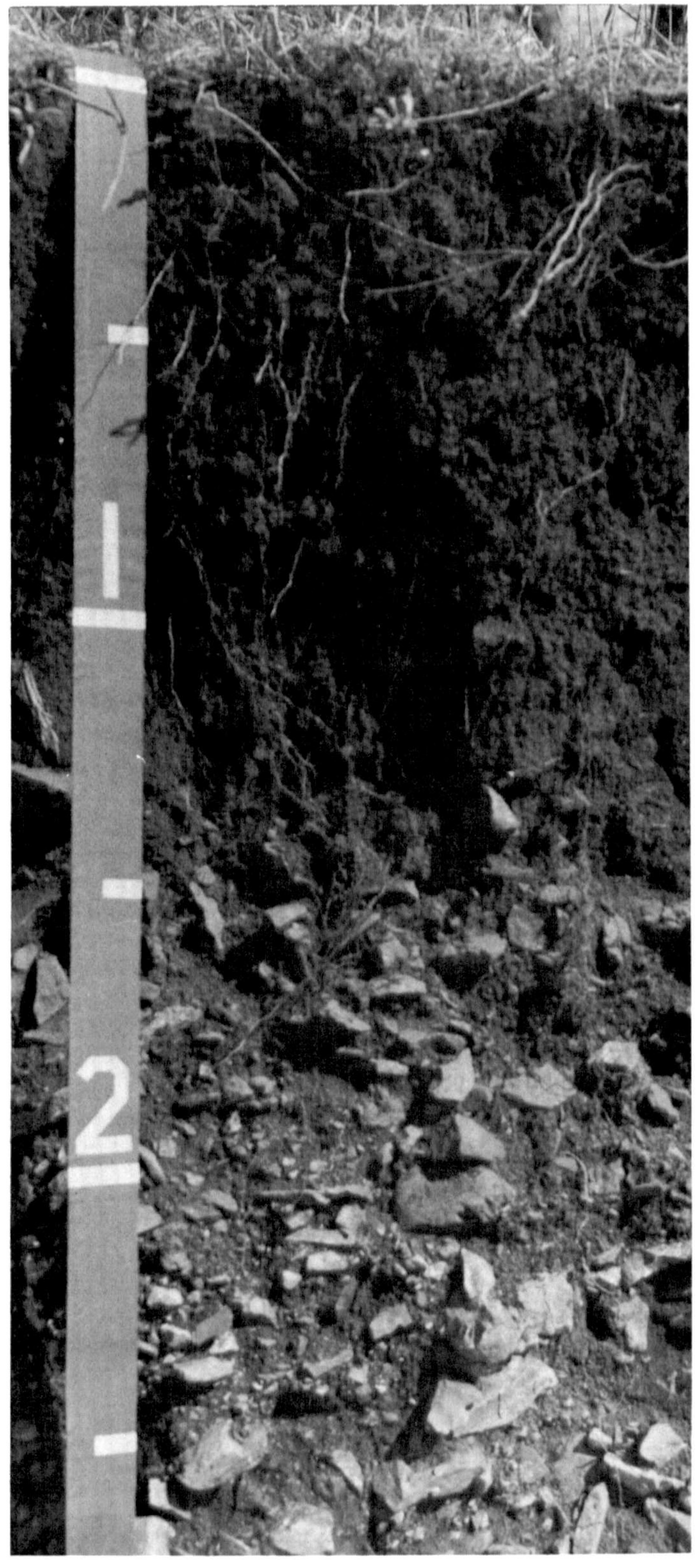


Figure 11.—Profile of Nowata silt loam. The subsoil of cherty silty clay loam is at a depth of about 15 inches. Depth is marked in feet.

A3—10 to 15 inches; dark brown (7.5YR 3/2) silt loam, dark brown (7.5YR 4/2) dry; moderate medium granular structure; hard, friable; about 15 percent chert fragments, by volume; medium acid; gradual smooth boundary.
B21t—15 to 26 inches; dark brown (7.5YR 4/2) cherty silty clay loam, brown (7.5YR 5/2) dry; moderate fine subangular blocky structure; hard, firm; about 65 percent chert fragments, by volume; few fine black concretions; medium acid; gradual smooth boundary.
B22t—26 to 36 inches; brown (7.5YR 4/4) cherty silty clay loam, brown (7.5YR 5/4) dry; moderate fine subangular blocky structure; very hard, firm; about 65 percent chert fragments, by volume; few fine black concretions; slightly acid; abrupt wavy boundary.
R—36 inches; limestone.

The thickness of the solum, or the depth to bedrock, ranges from 20 to 40 inches. In some pedons chert fragments less than 3 inches in diameter are throughout the solum. The content of these fragments ranges, by volume, from 1 to 10 percent in the A1 horizon and from 35 to 75 percent in the B2t horizon. Coarse cherty fragments larger than 3 inches in diameter are on the surface and throughout the solum. The content of these fragments is, by volume, less than 10 percent in the A1 horizon and ranges from 10 to 40 percent in the B2t horizon.

The A horizon has hue of 7.5YR or 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 2 or 3. It is medium acid or slightly acid. The B2t horizon has hue of 5YR or 7.5YR, value of 4 or 5 (5 or 6 dry), and chroma of 2 to 4. It ranges from medium acid to neutral.

Osage series

The Osage series consists of deep, poorly drained, very slowly permeable soils on flood plains. These soils formed in clayey alluvial sediments. Slope ranges from 0 to 2 percent.

Osage soils are similar to Zaar soils and are commonly adjacent to Lanton and Zaar soils. The somewhat poorly drained Zaar soils are on foot slopes. The somewhat poorly drained Lanton soils are in the slightly higher, convex areas near the stream channels. They contain less clay than the Osage soils.

Typical pedon of Osage silty clay, 1,750 feet north and 30 feet east of the southwest corner of sec. 25, T. 25 S., R. 24 E.

Ap—0 to 7 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; weak fine granular structure; very hard, very firm; slightly acid; abrupt smooth boundary.
A12—7 to 13 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; few fine faint brown (10YR 5/3) mottles; weak fine blocky structure; very hard, very firm; slightly acid; gradual smooth boundary.
B21g—13 to 30 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; few medium faint brown (10YR 5/3) mottles; moderate medium blocky structure; very hard, very firm; neutral; gradual smooth boundary.
B22g—30 to 44 inches; dark gray (10YR 4/1) silty clay, gray (10YR 5/1) dry; common medium distinct yellowish brown (10YR 5/4) mottles; moderate coarse blocky structure; very hard, very firm; dark organic stains on broken faces of peds; neutral; diffuse smooth boundary.
B3g—44 to 60 inches; dark gray (10YR 4/1) silty clay, gray (10YR 6/1) dry; common medium distinct yellowish brown (10YR 5/4) mottles; weak coarse blocky structure; very hard, very firm; mildly alkaline.

The thickness of the solum ranges from 40 to 60 inches or more. The mollic epipedon ranges from 24 to 40 inches in thickness and extends into the B2g horizon in most pedons.

The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1 or 2. It is dominantly silty clay but in some pedons is silty clay loam or clay. It ranges from medium acid to neutral. The B2 horizon has hue of 10YR or 2.5Y, value of 3 to 5 (4 to 6 dry), and chroma of 1.5 or less. The B horizon is slightly acid or neutral in the upper part and neutral or mildly alkaline in the lower part. In some pedons the lower part has carbonate concretions or gypsum crystals.

Parsons series

The Parsons series consists of deep, somewhat poorly drained, very slowly permeable soils on uplands. These soils formed in a thin mantle of loess and in old alluvial sediments. Slope ranges from 0 to 2 percent.

The Parsons soils in this survey area have lower chroma in the Ap horizon, a slightly thicker A2 horizon, and a thinner B2t horizon than is defined as the range for the Parsons series. These differences, however, do not significantly affect the use or behavior of the soils.

Parsons soils are similar to Leanna soils and are commonly adjacent to Kenoma soils. The Leanna soils have a mollic epipedon that is more than 10 inches thick. They are on low stream terraces. The Kenoma soils lack an albic horizon. They are gently sloping and are on the lower ridgetops.

Typical pedon of Parsons silt loam (fig. 12), 570 feet north and 50 feet west of the southeast corner of sec. 20, T. 24 S., R. 25 E.

Ap—0 to 7 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; weak very fine granular structure; slightly hard, very friable; slightly acid; clear smooth boundary.
A21—7 to 11 inches; dark gray (10YR 4/1) silt loam, gray (10YR 5/1) dry; weak fine and very fine

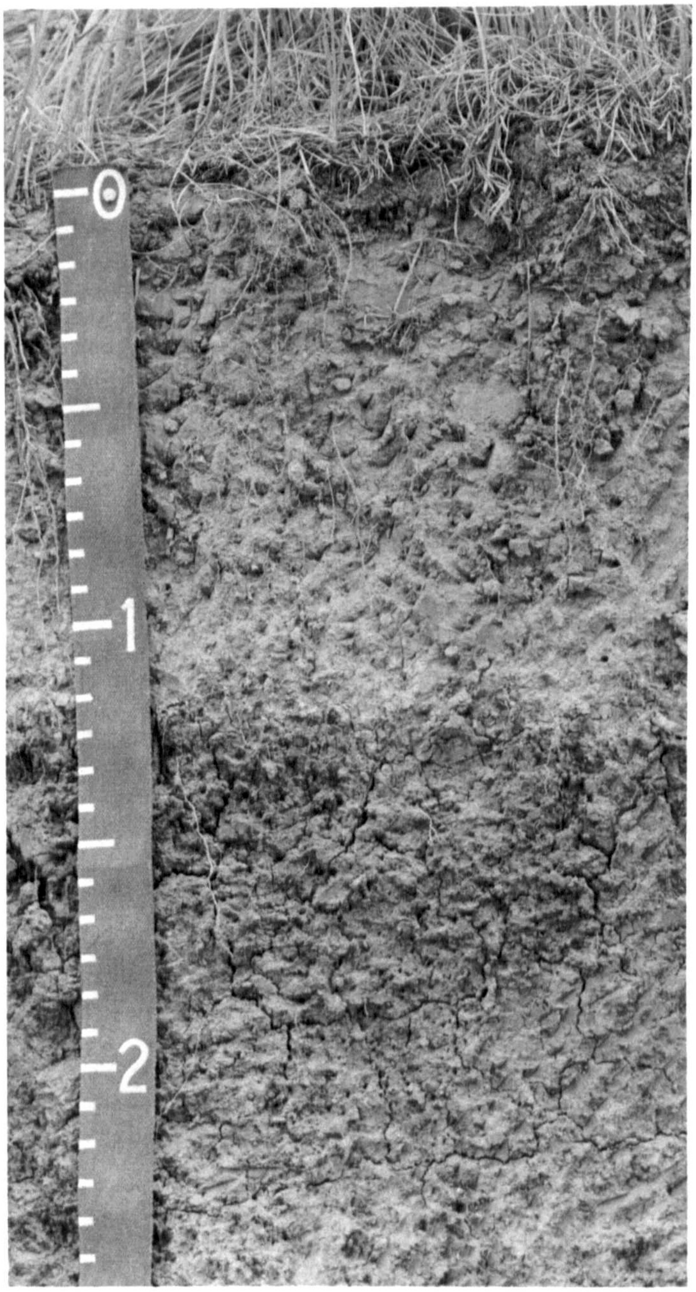


Figure 12.—Profile of Parsons silt loam. The light colored subsurface layer extends to a depth of about 15 inches. Depth is marked in feet.

granular structure; slightly hard, very friable; strongly acid; clear smooth boundary.

A22—11 to 15 inches; gray (10YR 5/1) silt loam, light gray (10YR 7/1) dry; few fine distinct yellowish brown (10YR 5/6) mottles; weak fine granular structure; slightly hard, very friable; strongly acid; abrupt smooth boundary.

B21t—15 to 20 inches; dark gray (10YR 4/1) silty clay, gray (10YR 5/1) dry; common fine and medium distinct strong brown (7.5YR 5/6) mottles; moderate fine and medium blocky structure; very hard, very firm; light gray (10YR 7/1) silt coatings on peds; strongly acid; gradual smooth boundary.

B22t—20 to 27 inches; dark gray (10YR 4/1) silty clay, grayish brown (10YR 5/2) dry; common fine and medium distinct yellowish brown (10YR 5/6) mottles; weak fine and medium blocky and subangular blocky structure; very hard, very firm; strongly acid; gradual smooth boundary.

B3—27 to 40 inches; dark gray (10YR 4/1) silty clay, gray (10YR 5/1) dry; common fine and medium distinct brown (7.5YR 4/4) mottles; weak medium subangular blocky structure; very hard, very firm; clay films on faces of peds; black coatings in old root channels; few fine black concretions; neutral; gradual smooth boundary.

C—40 to 60 inches; gray (10YR 6/1) silty clay, light gray (10YR 7/1) dry; many coarse distinct brown (7.5YR 4/4) mottles; massive; hard, firm; black coatings in old root channels; common soft black masses; neutral.

The thickness of the solum ranges from 40 to 60 inches. The mollic epipedon is less than 10 inches thick.

The A1 or Ap horizon has hue of 10YR, value of 3 or 4 (4 or 5 dry), and chroma of 1 or 2. The A2 horizon has hue of 10YR, value of 4 or 5 (5 to 7 dry), and chroma of 1 or 2. The A horizon ranges from strongly acid to slightly acid. The B2t horizon has hue of 10YR, value of 4 or 5 (5 to 7 dry), and chroma of 1 or 2. It is silty clay, silty clay loam, or clay averaging as low as 35 percent clay in some pedons and as high as 55 percent clay in others. It ranges from strongly acid to slightly acid. The B3 and C horizons have colors similar to those of the B2t horizon. They are silty clay or silty clay loam. They range from strongly acid to mildly alkaline.

Ringo series

The Ringo series consists of moderately deep, moderately well drained, very slowly permeable soils on uplands. These soils formed in material weathered from calcareous shale. Slope ranges from 9 to 15 percent.

Ringo soils are similar to Eram soils and are commonly adjacent to Clareson and Zaar soils. The Eram soils have an argillic horizon. They are on the lower side slopes. The Clareson soils have a clayey-skeletal subsoil that overlies limestone bedrock. They are on ridgetops. The deep Zaar soils lack an argillic horizon. They are on foot slopes.

Typical pedon of Ringo silty clay, in an area of Ringo-Clareson complex, 9 to 15 percent slopes, 1,000 feet west and 100 feet south of the northeast corner of sec. 20, T. 26 S., R. 22 E.

A1—0 to 10 inches; very dark grayish brown (10YR 3/2) silty clay, dark grayish brown (10YR 4/2) dry; strong fine subangular blocky structure; very hard, very firm; slight effervescence in the lower part; mildly alkaline; clear smooth boundary.

B1—10 to 17 inches; dark grayish brown (2.5Y 4/2) silty clay, grayish brown (2.5Y 5/2) dry; moderate medium subangular blocky structure; very hard, very firm; slight effervescence; moderately alkaline; gradual smooth boundary.

B2—17 to 25 inches; dark grayish brown (2.5Y 4/2) silty clay, light brownish gray (2.5Y 6/2) dry; few fine faint yellowish brown (10YR 5/6) mottles; strong medium blocky structure; very hard, very firm; few soft lime concretions; strong effervescence; moderately alkaline; gradual smooth boundary.

B3—25 to 30 inches; grayish brown (2.5Y 5/2) silty clay, light brownish gray (2.5Y 6/2) dry; weak coarse blocky structure; few soft shale fragments; hard, firm; common medium lime concretions; strong effervescence; moderately alkaline; clear smooth boundary.

Cr—30 inches; calcareous shale.

The thickness of the solum, or the depth to shale, ranges from 20 to 40 inches. The mollic epipedon ranges from 8 to 18 inches in thickness. The depth to free carbonates ranges from 0 to 16 inches. The solum is dominantly silty clay, but the range includes silty clay loam and clay. The content of clay averages as low as 35 percent in some pedons and as high as 50 percent in others.

The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1 or 2. It ranges from slightly acid to mildly alkaline. The B2 horizon has hue of 10YR or 2.5YR, value of 4 or 5 (5 or 6 dry), and chroma of 2 to 4. It is mildly alkaline or moderately alkaline.

Tamaha series

The Tamaha series consists of deep, moderately well drained, very slowly permeable soils on uplands. These soils formed in material weathered from shale. Slope ranges from 1 to 5 percent.

Tamaha soils are similar to Dennis soils and are commonly adjacent to Kenoma and Osage soils. The Dennis soils have a mollic epipedon. They are on foot slopes. The Kenoma soils have a mollic epipedon and lack a B1 horizon. They are on ridgetops. The poorly drained Osage soils are on flood plains.

Typical pedon of Tamaha silt loam, 1 to 5 percent slopes, 2,100 feet north and 2,200 feet west of the southeast corner of sec. 30, T. 23 S., R. 25 E.

Ap—0 to 7 inches; dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; weak fine granular structure; slightly hard, friable; slightly acid; abrupt smooth boundary.

B1—7 to 12 inches; dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; few fine faint strong brown (7.5YR 5/6) mottles; moderate fine subangular blocky structure; hard, firm; grayish silt coatings on faces of some peds; strongly acid; gradual smooth boundary.

B21t—12 to 26 inches; yellowish brown (10YR 5/4) silty clay, light yellowish brown (10YR 6/4) dry; common medium distinct strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; very hard, very firm; few grayish silt coatings on faces of peds; few fine black concretions; strongly acid; gradual smooth boundary.

B22t—26 to 40 inches; yellowish brown (10YR 5/4) silty clay, pale brown (10YR 6/3) dry; few medium faint grayish brown (10YR 5/2) and many coarse faint strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; very hard, very firm; common fine black concretions; medium acid; gradual smooth boundary.

B3—40 to 60 inches; yellowish brown (10YR 5/4) silty clay loam, pale brown (10YR 6/3) dry; few fine faint dark yellowish brown (10YR 4/4) mottles; weak coarse subangular blocky structure; hard, firm; few fine black concretions; slightly acid.

The solum is more than 60 inches thick. The Ap horizon has hue of 10YR, value of 4 or 5 (6 or 7 dry), and chroma of 2 to 4. It is dominantly silt loam but in some pedons is loam. It ranges from very strongly acid to slightly acid. The B2t horizon has hue of 10YR, value of 4 to 6 (5 to 7 dry), and chroma of 3 to 6. It is silty clay or silty clay loam that averages as low as 35 percent clay in some pedons and as high as 45 percent clay in others. It ranges from strongly acid to neutral.

Verdigris series

The Verdigris series consists of deep, well drained, moderately permeable soils on flood plains. These soils formed in alluvial sediments. Slope ranges from 0 to 2 percent.

Verdigris soils are similar to Lanton and Mason soils and are commonly adjacent to those soils. The somewhat poorly drained Lanton soils are in the slightly higher, convex areas on flood plains. The well drained Mason soils are on stream terraces. They have an argillic horizon.

Typical pedon of Verdigris silt loam, 700 feet south and 30 feet east of the northwest corner of sec. 31, T. 23 S., R. 24 E.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; slightly hard, friable; neutral; abrupt smooth boundary.

A12—9 to 22 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry;

moderate medium granular structure; slightly hard, friable; slightly acid; gradual smooth boundary.

AC—22 to 44 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; weak fine subangular blocky structure; slightly hard, friable; few worm casts and pores; slightly acid; gradual smooth boundary.

C—44 to 60 inches; dark brown (10YR 4/3) silt loam, light brownish gray (10YR 6/2) dry; massive; slightly hard, friable; slightly acid.

The mollic epipedon ranges from 24 to 48 inches in thickness. Reaction ranges from medium acid to neutral throughout the profile.

The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 2 or 3. It is dominantly silt loam, but the range includes loam and silty clay loam. The C horizon has hue of 7.5YR or 10YR, value of 4 or 5 (5 to 7 dry), and chroma of 2 or 3. It is silt loam, loam, or silty clay loam.

Zaar series

The Zaar series consists of deep, somewhat poorly drained, very slowly permeable soils on foot slopes in the uplands. These soils formed in material weathered from shale. Slope ranges from 0 to 6 percent.

Zaar soils are similar to Osage soils and are commonly adjacent to Kenoma and Ringo soils. The poorly drained Osage soils are on flood plains. The Kenoma soils have an argillic horizon. They are on ridgetops. The moderately deep Ringo soils are on the upper side slopes.

Typical pedon of Zaar silty clay, 0 to 2 percent slopes, 520 feet east and 20 feet south of the northwest corner of sec. 15, T. 26 S., R. 22 E.

Ap—0 to 7 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; weak very fine granular structure; hard, firm; slightly acid; abrupt smooth boundary.

A12—7 to 15 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; weak medium blocky structure; very hard, very firm; slightly acid; gradual smooth boundary.

B21—15 to 24 inches; black (10YR 2/1) silty clay, very dark grayish brown (10YR 3/2) dry; few fine faint dark brown (10YR 4/3) mottles; weak fine and medium blocky structure; very hard, very firm; neutral; gradual smooth boundary.

B22—24 to 36 inches; very dark grayish brown (10YR 3/2) silty clay, grayish brown (10YR 5/2) dry; common fine faint dark yellowish brown (10YR 4/4) mottles; moderate medium blocky structure; very hard, very firm; few fine black concretions; neutral; gradual smooth boundary.

B3—36 to 48 inches; dark grayish brown (2.5Y 4/2) silty clay, grayish brown (2.5Y 5/2) dry; common medium distinct yellowish brown (10YR 5/4) mottles; moderate coarse blocky structure; very hard, very firm; few fine lime concretions; mildly alkaline; diffuse smooth boundary.

C—48 to 60 inches; dark grayish brown (2.5Y 4/2) silty clay, grayish brown (2.5Y 5/2) dry; common medium distinct yellowish brown (10YR 5/4) mottles; massive; very hard, very firm; few fine black lime concretions; moderately alkaline.

The thickness of the solum ranges from 40 to 60 inches. The mollic epipedon ranges from 20 to 40 inches in thickness and extends into the B horizon. The texture is silty clay loam, silty clay, or clay throughout the profile. The content of clay averages as low as 38 percent in some pedons and as high as 60 percent in others.

The A horizon has hue of 10YR, value of 2 or 3 (3 or 4 dry), and chroma of 1 or 2. It is medium acid or slightly acid. The B2 horizon has hue of 10YR or 2.5Y, value of 2 to 4 (3 to 5 dry), and chroma of 1 or 2. It ranges from slightly acid to mildly alkaline. The B3 and C horizons have hue of 10YR or 2.5Y, value of 4 or 5 (5 or 6 dry), and chroma of 2 to 4.

factors of soil formation

The characteristics of a soil at any given place are determined by the interaction of five factors of soil formation—climate, plant and animal life, parent material, relief, and time. Each of these factors affects the formation of every soil, and each modifies the effects of the other four. The effects of each vary from place to place.

Climate and plants act on the parent material and gradually change it to a natural body of soil. Relief modifies the effects of climate and plants, mainly through its effect on runoff and temperature. The nature of the parent material affects the kind of soil that forms. Time is needed for changing the parent material into a soil. Generally, a long period is needed for the development of distinct horizons.

parent material

The weathering of accumulated geologic material results in the parent material in which most soils form. Parent material accumulates through the processes of freezing and thawing and abrasion, through deposition by wind and water, and through chemical processes. The soils in Bourbon County formed in material weathered from bedrock and in old alluvium, recent alluvium, and eolian deposits.

Bates, Catoosa, Eram, Nowata, Ringo, and other soils formed in material weathered from bedrock. Bates soils formed in material weathered from sandstone, Catoosa soils in material weathered from limestone, Eram and Ringo soils in material weathered from shale, and Nowata soils in material weathered from cherty limestone.

The broader upland divides are covered with old alluvial deposits of gravel, sand, silt, and clay. These deposits range from a few inches to about 10 feet in thickness. In most areas Kenoma and Parsons soils formed in these deposits.

Recent alluvium is water-deposited sand, silt, and clay on flood plains and low stream terraces. Lanton, Leanna, Mason, Osage, and Verdigris soils, which are in the larger valleys throughout the county, formed in these deposits.

Eolian silt and clay are deposited in most of the nearly level areas on the tops of ridges on broad upland divides. These deposits generally are less than 2 feet thick. As a result, determining their effect on the soils in the county is difficult. In some areas a thin eolian deposit is at the surface of the Kenoma soils.

climate

Climate affects chemical and physical weathering and the biological processes at work in the parent material. Soil-forming processes are most active when the soil is warm and moist. Precipitation has a major effect on the weathering of soils. Alternating periods of wetting and drying and of freezing and thawing promote the physical weathering of soils and parent material. Climatic differences within the county have not clearly differentiated the soils. Detailed information about the climate is given under the heading "General nature of the county."

plant and animal life

Plants and animals furnish organic matter to the soil and bring plant nutrients from the lower layers to the surface. Trunks, stems, leaves, and roots are the principal sources of organic matter. Additions of organic matter modify the color and the structure and other physical properties of the soils. They also modify the chemical properties. Burrowing animals mix the soil horizons. Earthworms feed on organic matter and channel through the soil horizons.

Most of the upland soils in Bourbon County formed under the tall prairie grasses. A few formed under oak and hickory. The chemical properties of Bolivar and Hector soils, which formed under trees, differ from those of Bates and Collinsville soils, which formed under grasses.

relief

Relief affects soil formation through its effect on drainage, runoff, plant cover, and soil temperature. The soil temperature, for example, is slightly lower on the east- and north-facing slopes than on the west- and south-facing slopes. Most important is the effect that relief has had on the movement of water on the surface and into the soil.

The runoff rate is higher on the steeper soils in the uplands than on the less steep soils. As a result, erosion is more extensive. Relief has retarded the formation of Collinsville soils, which formed in the oldest parent material in the county. Runoff is rapid on these strongly sloping soils, and much of the soil material is removed as soon as the soil forms.

Soils having distinct horizons generally formed in the less sloping areas. The nearly level Mason soils on stream terraces, for example, formed in the younger parent material in the county but have distinct horizons. Most of the precipitation received by these soils penetrates the surface.

time

Differences in the length of time that the parent materials have been in place commonly are reflected in the degree of profile development. Some soils form rapidly; others form slowly.

The soils in Bourbon County range from immature to mature. Those on low bottom land, such as Verdigris soils, are subject to stream overflow. They receive new sediment with each flood. As a result, they are immature. They have a thick, dark surface layer that has a moderate content of organic matter. They have not been in place long enough, however, for a significant amount of fine clay to move downward through the profile. In contrast, accumulations of translocated fine clay are evident in the subsoil of the mature Kenoma soils. Thousands of years are needed for such translocations.

references

(1) American Association of State Highway [and Transportation] Officials. 1970. Standard specifications for highway materials and methods of sampling and testing. Ed. l0, 2 vols., illus.

(2) American Society for Testing and Materials. 1974. Method for classification of soils for engineering purposes. ASTM Stand. D 2487-69. *In* 1974 Annual Book of ASTM Standards, Part 19, 464 pp., illus.

(3) Layton, M. H., and C. E. Dornberger. 1931. Soil survey of Bourbon County, Kansas. U.S. Dep. Agric., Bur. of Chem. and Soils, 29 pp., illus.

(4) United States Department of Agriculture. 1951. Soil survey manual. U.S. Dep. Agric. Handb. 18, 503 pp., illus. [Supplements replacing pp. 173-188 issued May 1962]

(5) United States Department of Agriculture. 1975. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. Soil Conserv. Serv., U.S. Dep. Agric. Handb. 436, 754 pp., illus.

(6) United States Department of Commerce, Bureau of the Census. 1977. 1974 census of agriculture. Vol. 1, part 16, chap. IV, pp. 37-42.

glossary

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Base saturation. The degree to which material having cation exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation exchange capacity.

Bedding system. A series of elevated beds separated by shallow ditches and created by plowing or grading fields. A bedding system improves surface drainage.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to flooding.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15.2 to 38.1 centimeters (6 to 15 inches) long.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Drainage class (natural). Refers to the removal of water from the soil. Drainage classes are determined on the basis of an overall evaluation of water removal as influenced by climate, slope, and position on the landscape. Precipitation, runoff, amount of moisture infiltrating the soil, and rate of water movement through the soil affect the degree and duration of wetness. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. The soils in this class generally are free of mottles throughout. They commonly are shallow, very porous, or steep, or a combination of these.

Somewhat excessively drained.—Water is removed from the soil rapidly. The soils in this class generally are free of mottles throughout. They commonly are shallow or moderately deep, very porous, or steep, or a combination of these.

Well drained.—Water is removed from the soil so readily that the upper 40 inches generally does not have the mottles or dull colors related to wetness.

Moderately well drained.—Water is removed from the soil so slowly that the upper 20 to 40 inches has the mottles or dull colors related to wetness. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.

Somewhat poorly drained.—Water is removed from the soil so slowly that the upper 10 to 20 inches has the mottles or dull colors related to wetness. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.

Poorly drained.—Water is removed so slowly that either the soil is periodically saturated or the upper 10 inches has the mottles or dull colors related to wetness. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water is at or on the surface most of the time. The soils in this class commonly have a slowly permeable layer, have a water table, or receive runoff or seepage, or they are characterized by a combination of these.

Drainage, surface. Runoff, or surface flow of water, from an area.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature. for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil does not provide a source of gravel or sand for construction purposes.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fine textured soil. Sandy clay, silty clay, and clay.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Hardpan. A hardened or cemented soil horizon, or layer. The soil material is sandy, loamy, or clayey and is cemented by iron oxide, silica, calcium carbonate, or other substance.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an upper case letter represents the major horizons. Numbers or lower case letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the *Soil Survey Manual*. The major horizons of mineral soil are as follows:

O horizon.—An organic layer of fresh and decaying plant residue at the surface of a mineral soil.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil does not have a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Large stones (in tables). Rock fragments 3 inches (7.5 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Parent material. The unconsolidated organic and mineral material in which soil forms.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.20 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Slickspot. A small area of soil having a puddled, crusted, or smooth surface and an excess of exchangeable sodium. The soil is generally silty or clayey, is slippery when wet, and is low in productivity.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to insure satisfactory performance of the soil for a specific use.

Slow intake (in tables). The slow movement of water into the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.5 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 mm in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates

longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the profile below plow depth.

Subsurface layer. Any surface soil horizon (A1, A2, or A3) below the surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A horizon. Includes all subdivisions of this horizon (A1, A2, and A3).

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

Month	Temperature					Precipitation				
	Average daily maximum	Average daily minimum	Average daily	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	In	In	In		In
January----	43.7	22.6	33.2	72	-7	1.30	0.49	1.85	3	4.2
February---	49.4	26.9	38.2	74	2	1.58	0.43	2.34	3	3.3
March------	57.6	33.8	45.7	85	5	2.55	1.38	3.80	5	3.2
April------	71.2	46.8	59.0	90	25	4.24	2.39	6.33	6	0.3
May--------	79.3	56.3	67.8	94	33	5.03	2.74	6.37	8	0.0
June-------	87.5	66.5	76.5	99	48	5.59	2.85	8.42	7	0.0
July-------	92.9	69.5	81.2	106	53	4.12	1.44	6.26	5	0.0
August-----	92.7	68.2	80.5	106	51	3.89	1.69	5.12	5	0.0
September--	84.9	59.4	72.2	100	40	4.73	1.77	7.78	6	0.0
October----	74.6	48.8	61.8	92	25	3.24	0.91	5.41	5	0.0
November---	58.6	35.9	47.3	80	12	1.86	0.41	3.35	3	1.1
December---	46.5	26.9	36.7	73	-3	1.75	0.57	2.67	4	4.2
Year-----	69.9	46.8	58.3	106	-7	39.88	30.91	46.47	60	16.3

TABLE 2.--FREEZE DATES IN SPRING AND FALL

Probability	Minimum temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	April 10	April 18	April 30
2 years in 10 later than--	April 5	April 13	April 25
5 years in 10 later than--	March 27	April 3	April 15
First freezing temperature in fall:			
1 year in 10 earlier than--	October 27	October 16	October 6
2 years in 10 earlier than--	October 31	October 21	October 10
5 years in 10 earlier than--	November 9	October 31	October 20

TABLE 3.--GROWING SEASON

Probability	Daily minimum temperature		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	207	190	163
8 years in 10	214	197	171
5 years in 10	227	211	188
2 years in 10	240	225	204
1 year in 10	247	232	212

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
Ba	Bates loam, 1 to 4 percent slopes	9,700	2.4
Bc	Bates loam, 4 to 7 percent slopes	3,900	1.0
Bd	Bates loam, 4 to 7 percent slopes, eroded	1,160	0.3
Bh	Bolivar-Hector fine sandy loams, 5 to 15 percent slopes	1,300	0.3
Ca	Catoosa silt loam	58,000	14.1
Cs	Clareson stony silty clay loam, 1 to 4 percent slopes	55,000	13.4
De	Dennis silt loam, 1 to 3 percent slopes	30,000	7.3
Df	Dennis silt loam, 3 to 6 percent slopes	31,000	7.6
Ec	Eram-Collinsville complex, 5 to 12 percent slopes	5,400	1.3
Ke	Kenoma silt loam, 1 to 3 percent slopes	48,500	11.9
La	Lanton silty clay loam	8,000	2.0
Le	Leanna silt loam	1,500	0.4
Ma	Mason silt loam	5,200	1.3
No	Nowata silt loam, 3 to 5 percent slopes	13,900	3.4
Or	Orthents, hilly	4,200	1.0
Os	Osage silty clay	4,200	1.0
Pa	Parsons silt loam	18,000	4.4
Pt	Pits, quarries	380	0.1
Rc	Ringo-Clareson complex, 9 to 15 percent slopes	27,500	6.7
Ta	Tamaha silt loam, 1 to 5 percent slopes	1,900	0.5
Ve	Verdigris silt loam	18,600	4.5
Vf	Verdigris silt loam, channeled	2,000	0.5
Za	Zaar silty clay, 0 to 2 percent slopes	32,000	7.8
Zb	Zaar silty clay, 2 to 6 percent slopes	27,300	6.7
	Water	320	0.1
	Total	408,960	100.0

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE

[Yields are those that can be expected under a high level of management. Only arable soils are listed. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Winter wheat	Grain sorghum	Soybeans	Corn	Alfalfa hay	Tall fescue
	Bu	Bu	Bu	Bu	Ton	AUM*
Ba----------------------- Bates	35	55	30	45	3.0	5.5
Bc----------------------- Bates	31	45	20	40	2.0	5.5
Bd----------------------- Bates	27	35	15	30	---	5.0
Bh----------------------- Bolivar-Hector	---	---	---	---	---	4.0
Ca----------------------- Catoosa	38	60	25	55	3.5	5.5
De----------------------- Dennis	40	75	30	70	4.0	6.0
Df----------------------- Dennis	36	70	26	65	3.5	6.0
Ke----------------------- Kenoma	35	65	26	60	3.5	5.0
La----------------------- Lanton	35	95	30	90	4.0	7.5
Le----------------------- Leanna	35	80	30	75	4.0	7.0
Ma----------------------- Mason	42	100	36	95	5.5	7.5
No----------------------- Nowata	35	45	20	40	2.5	5.0
Os----------------------- Osage	30	65	25	60	2.5	6.5
Pa----------------------- Parsons	35	70	28	65	3.5	5.0
Ta----------------------- Tamaha	32	60	24	55	3.0	5.5
Ve----------------------- Verdigris	38	95	34	90	5.5	7.5
Za----------------------- Zaar	34	65	30	60	3.5	5.5
Zb----------------------- Zaar	30	55	26	55	3.5	5.5

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES

[Only the soils that support rangeland vegetation suitable for grazing are listed]

Soil name and map symbol	Range site name	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Compo- sition
			Lb/acre		Pct
Ba, Bc, Bd: Bates	Loamy Upland	Favorable	7,000	Big bluestem	35
		Normal	5,500	Little bluestem	25
		Unfavorable	4,500	Indiangrass	5
				Switchgrass	5
Bh*:					
Bolivar	Savannah	Favorable	5,000	Big bluestem	25
		Normal	3,700	Little bluestem	20
		Unfavorable	3,500	Trees and shrubs	15
				Indiangrass	10
				Switchgrass	5
Hector	Shallow Savannah	Favorable	3,500	Big bluestem	20
		Normal	2,500	Little bluestem	20
		Unfavorable	1,500	Trees and shrubs	20
				Indiangrass	10
				Switchgrass	5
Ca: Catoosa	Loamy Upland	Favorable	6,500	Big bluestem	30
		Normal	5,000	Little bluestem	25
		Unfavorable	4,000	Indiangrass	10
				Sideoats grama	10
				Switchgrass	5
Cs: Claveson	Shallow Flats	Favorable	5,000	Little bluestem	30
		Normal	4,000	Big bluestem	20
		Unfavorable	2,500	Sideoats grama	15
				Indiangrass	10
				Switchgrass	5
De, Df: Dennis	Loamy Upland	Favorable	7,000	Big bluestem	35
		Normal	5,500	Little bluestem	25
		Unfavorable	4,500	Indiangrass	15
				Switchgrass	5
Ec*:					
Eram	Clay Upland	Favorable	6,500	Big bluestem	25
		Normal	4,500	Little bluestem	25
		Unfavorable	3,000	Indiangrass	15
				Switchgrass	10
				Tall dropseed	5
				Sideoats grama	5
Collinsville	Shallow Sandstone	Favorable	4,500	Little bluestem	30
		Normal	3,700	Big bluestem	20
		Unfavorable	2,500	Indiangrass	10
				Switchgrass	10
				Sideoats grama	10
Ke: Kenoma	Clay Upland	Favorable	6,500	Big bluestem	25
		Normal	4,500	Little bluestem	25
		Unfavorable	3,000	Indiangrass	15
				Switchgrass	10
				Tall dropseed	5
				Sideoats grama	5
La: Lanton	Loamy Lowland	Favorable	10,000	Prairie cordgrass	30
		Normal	8,000	Big bluestem	15
		Unfavorable	6,000	Switchgrass	15
				Eastern gamagrass	10
				Indiangrass	10
				Sedges	5

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site name	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
Le: Leanna	Clay Lowland	Favorable	10,000	Prairie cordgrass	35
		Normal	8,000	Big bluestem	15
		Unfavorable	6,000	Eastern gamagrass	10
				Indiangrass	10
				Switchgrass	10
				Sedges	5
Ma: Mason	Loamy Lowland	Favorable	10,000	Big bluestem	30
		Normal	9,000	Indiangrass	20
		Unfavorable	7,000	Switchgrass	10
				Eastern gamagrass	10
				Prairie cordgrass	5
No: Nowata	Loamy Upland	Favorable	6,000	Big bluestem	30
		Normal	4,500	Little bluestem	25
		Unfavorable	3,500	Indiangrass	10
				Switchgrass	10
				Sideoats grama	5
Os: Osage	Clay Lowland	Favorable	9,000	Prairie cordgrass	40
		Normal	7,500	Switchgrass	15
		Unfavorable	6,000	Big bluestem	15
				Eastern gamagrass	5
				Indiangrass	5
				Sedges	5
Pa: Parsons	Clay Upland	Favorable	6,000	Big bluestem	25
		Normal	4,500	Little bluestem	20
		Unfavorable	2,500	Switchgrass	15
				Indiangrass	15
				Sedges	5
				Tall dropseed	5
Rc*:					
Ringo	Clay Upland	Favorable	6,000	Big bluestem	25
		Normal	4,500	Little bluestem	20
		Unfavorable	3,000	Indiangrass	15
				Switchgrass	15
				Tall dropseed	5
				Sideoats grama	5
Clareson	Shallow Flats	Favorable	5,000	Little bluestem	30
		Normal	4,000	Big bluestem	20
		Unfavorable	2,500	Sideoats grama	15
				Indiangrass	10
				Switchgrass	5
Ta: Tamaha	Savannah	Favorable	5,000	Big bluestem	30
		Normal	3,500	Little bluestem	15
		Unfavorable	2,500	Indiangrass	10
Ve, Vf: Verdigris	Loamy Lowland	Favorable	10,000	Big bluestem	30
		Normal	8,500	Indiangrass	15
		Unfavorable	6,000	Eastern gamagrass	15
				Switchgrass	10
				Prairie cordgrass	5
Za, Zb: Zaar	Clay Upland	Favorable	7,500	Big bluestem	30
		Normal	5,000	Little bluestem	25
		Unfavorable	3,500	Indiangrass	15
				Switchgrass	10

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY

[Only the soils suitable for production of commercial trees are listed. Absence of an entry indicates that information was not available]

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Management concerns: Equipment limitation	Management concerns: Seedling mortality	Management concerns: Plant competition	Potential productivity: Common trees	Potential productivity: Site index	Trees to plant
Bh*:								
Bolivar	4o	Slight	Slight	Slight	Slight	White oak	57	Green ash, shortleaf pine.
						Black oak	60	
						Northern red oak	60	
						Black walnut	50	
Hector	5d	Slight	Slight	Moderate	Slight	Shortleaf pine	50	Shortleaf pine, loblolly pine.
La: Lanton	3w	Slight	Severe	Slight	Severe	Pin oak	80	Pecan, green ash, American sycamore, eastern cottonwood, black walnut.
						Eastern cottonwood	85	
						Pecan	50	
						Common hackberry	60	
						Green ash	75	
Le: Leanna	3o	Slight	Slight	Slight	Severe	Pin oak	80	Pecan, green ash, American sycamore, eastern cottonwood, black walnut.
						Eastern cottonwood	85	
						Pecan	50	
						Common hackberry	60	
						Green ash	75	
Ma: Mason	3o	Slight	Slight	Slight	Moderate	Northern red oak	70	Bur oak, green ash, black walnut, pecan, eastern cottonwood.
						Green ash	70	
						Black walnut	75	
						Eastern cottonwood	90	
Os: Osage	4w	Slight	Moderate	Severe	Severe	Pin oak	75	Pin oak, pecan, common hackberry, green ash.
						Pecan	50	
						Eastern cottonwood	65	
						Green ash	65	
Ta: Tamaha	5o	Slight	Slight	Slight	Moderate	Pine oak	55	Pin oak, pecan, bur oak.
						Pecan	55	
						Bur oak	50	
Ve, Vf: Verdigris	3o	Slight	Slight	Slight	Moderate	Eastern cottonwood	87	Eastern cottonwood, American sycamore, black walnut, pecan, bur oak.
						Bur oak	65	
						Common hackberry	70	
						Black walnut	70	
						Silver maple	60	
						Green ash	60	
						White oak	55	

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil]

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
Ba, Bc, Bd: Bates	Lilac, Peking cotoneaster, American plum, fragrant sumac.	Amur maple	Eastern redcedar, green ash, Russian mulberry, common hackberry.	Austrian pine, Scotch pine, honeylocust.	---
Bh*:					
Bolivar	Lilac, Peking cotoneaster, American plum, fragrant sumac.	Amur maple	Eastern redcedar, green ash, Russian mulberry, common hackberry.	Austrian pine, Scotch pine, honeylocust.	---
Hector	---	Flowering dogwood	Bitternut hickory, eastern redcedar, redbud, northern red oak, green ash, common hackberry.	Honeylocust	---
Ca: Catoosa	Lilac, Peking cotoneaster, American plum, fragrant sumac.	Amur maple	Green ash, eastern redcedar, Russian mulberry, common hackberry.	Austrian pine, Scotch pine, honeylocust.	---
Cs: Clareson	---	Flowering dogwood	Bitternut hickory, eastern redcedar, redbud, northern red oak, green ash, common hackberry.	Honeylocust	---
De, Df: Dennis	Lilac, fragrant sumac.	Eastern redcedar, Russian-olive, autumn-olive, common chokecherry.	Common hackberry, pin oak.	Austrian pine, osageorange, green ash, honeylocust.	---
Ec*:					
Eram	Lilac, fragrant sumac.	Eastern redcedar, Russian-olive, autumn-olive, common chokecherry.	Osageorange, honeylocust, common hackberry, pin oak.	Austrian pine, green ash.	---
Collinsville	---	---	Eastern redcedar, northern red oak, redbud, mulberry.	---	---
Ke: Kenoma	Lilac, fragrant sumac.	Eastern redcedar, Russian-olive, autumn-olive, common chokecherry.	Common hackberry, pin oak, honeylocust.	Green ash, Austrian pine, Siberian elm.	---
La: Lanton	American plum, redosier dogwood.	Common chokecherry, autumn-olive.	Eastern redcedar, redbud.	Russian mulberry, green ash, honeylocust, golden willow.	Silver maple, eastern cottonwood.
Le: Leanna	American plum, redosier dogwood.	Common chokecherry, autumn-olive.	Eastern redcedar, redbud.	Green ash, Russian mulberry, honeylocust, golden willow.	Silver maple, eastern cottonwood.

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
Ma: Mason	Fragrant sumac, lilac.	Autumn-olive, Peking cotoneaster.	Eastern redcedar, radiant crabapple.	Austrian pine, Scotch pine, green ash, honeylocust.	Silver maple, eastern cottonwood.
No: Nowata	---	---	Austrian pine, eastern redcedar.	Loblolly pine	---
Or*. Orthents					
Os: Osage	American plum, redosier dogwood.	Common chokecherry.	Eastern redcedar, redbud.	Russian-olive, green ash, honeylocust, golden willow.	Silver maple, eastern cottonwood.
Pa: Parsons	Lilac, fragrant sumac.	Russian-olive, autumn-olive, common chokecherry.	Eastern redcedar, common hackberry, honeylocust.	Austrian pine, green ash, Siberian elm, osageorange.	---
Pt*. Pits					
Rc*:					
Ringo	Lilac, fragrant sumac.	Russian-olive, autumn-olive, common chokecherry.	Eastern redcedar, common hackberry, honeylocust.	Green ash, Austrian pine, Siberian elm, osageorange.	---
Clareson	---	Flowering dogwood	Bitternut hickory, eastern redcedar, redbud, northern red oak, green ash, common hackberry.	Honeylocust	---
Ta: Tamaha	Lilac, fragrant sumac.	Eastern redcedar, Russian-olive, autumn-olive, common chokecherry.	Common hackberry, pin oak.	Honeylocust, Austrian pine, osageorange, green ash.	---
Ve, Vf: Verdigris	Fragrant sumac, lilac.	Peking cotoneaster, autumn-olive.	Eastern redcedar, radiant crabapple.	Austrian pine, honeylocust, green ash, Scotch pine.	Eastern cottonwood, silver maple.
Za, Zb: Zaar	Lilac, fragrant sumac.	Russian-olive, autumn-olive, common chokecherry.	Eastern redcedar, common hackberry, honeylocust.	Green ash, Austrian pine, Siberian elm, osageorange.	---

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Ba, Bc, Bd: Bates	Slight	Slight	Moderate: slope, small stones, depth to rock.	Slight.
Bh*:				
Bolivar	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Hector	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Slight.
Ca: Catoosa	Slight	Slight	Slight	Severe: erodes easily.
Cs: Clareson	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: percs slowly, large stones.	Moderate: large stones.
De, Df: Dennis	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Severe: erodes easily.
Ec*:				
Eram	Moderate: slope, wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Severe: slope.	Severe: erodes easily.
Collinsville	Severe: depth to rock.	Severe: depth to rock.	Severe: small stones.	Slight.
Ke: Kenoma	Severe: percs slowly.	Severe: percs slowly.	Severe: percs slowly.	Severe: erodes easily.
La: Lanton	Severe: floods, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
Le: Leanna	Severe: floods, wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness, erodes easily.
Ma: Mason	Severe: floods.	Moderate: percs slowly.	Moderate: percs slowly.	Severe: erodes easily.
No: Nowata	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, small stones, depth to rock.	Severe: erodes easily.
Or*. Orthents				
Os: Osage	Severe: floods, wetness, percs slowly.	Severe: wetness, too clayey, percs slowly.	Severe: too clayey, wetness.	Severe: wetness, too clayey.
Pa: Parsons	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness, erodes easily.

See footnote at end of table.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Pt*. Pits				
Rc*: Ringo	Severe: percs slowly, too clayey.	Severe: too clayey, percs slowly.	Severe: slope, too clayey, percs slowly.	Severe: too clayey.
Clareson	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: percs slowly, large stones.	Moderate: large stones.
Ta Tamaha	Severe: wetness, percs slowly.	Severe: percs slowly.	Severe: wetness, percs slowly.	Severe: erodes easily.
Ve Verdigris	Severe: floods.	Slight	Moderate: floods.	Slight.
Vf Verdigris	Severe: floods.	Moderate: floods.	Severe: floods.	Moderate: floods.
Za, Zb Zaar	Severe: wetness, percs slowly, too clayey.	Severe: too clayey, percs slowly.	Severe: too clayey, wetness.	Severe: too clayey.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--WILDLIFE HABITAT POTENTIALS

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Potential for habitat elements								Potential as habitat for--			
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
Ba, Bc, Bd Bates	Good	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.	Good.
Bh*:												
Bolivar	Fair	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.	Good.
Hector	Very poor.	Poor	Poor	Poor	Very poor.	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.	Poor.
Ca Catoosa	Fair	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.	Good.
Cs Clareson	Poor	Good	Good	Poor	Poor	Fair	Very poor.	Very poor.	Fair	Poor	Very poor.	Fair.
De Dennis	Good	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor	Good.
Df Dennis	Good	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.	Good.
Ec*:												
Eram	Fair	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.	Good.
Collinsville	Poor	Poor	Fair	Poor	Poor	Fair	Very poor.	Very poor.	Poor	Poor	Very poor.	Fair.
Ke Kenoma	Good	Good	Fair	Fair	Fair	Fair	Poor	Fair	Good	Fair	Poor	Fair.
La Lanton	Good	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair	Good.
Le Leanna	Fair	Good	Fair	Good	Good	Good	Fair	Fair	Fair	Good	Fair	Fair.
Ma Mason	Good	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.	Good.
No Nowata	Fair	Good	Good	Good	Good	Fair	Poor	Very poor.	Good	Good	Very poor.	Fair.
Or*. Orthents												
Os Osage	Fair	Fair	Fair	Fair	Fair	Fair	Poor	Good	Fair	Fair	Fair	Fair.
Pa Parsons	Fair	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair	Good.
Pt*. Pits												
Rc*:												
Ringo	Poor	Fair	Fair	Fair	Fair	Good	Poor	Very poor.	Fair	Fair	Very poor.	Fair.
Clareson	Poor	Good	Good	Poor	Poor	Fair	Very poor.	Very poor.	Fair	Poor	Very poor.	Fair.

See footnote at end of table.

TABLE 10.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements								Potential as habitat for--			
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
Ta------------------ Tamaha	Good	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.	Good.
Ve------------------ Verdigris	Good	Good	Good	Good	Good	Good	Poor	Fair	Good	Good	Poor	Good.
Vf------------------ Verdigris	Poor	Fair	Fair	Good	Good	Good	Poor	Fair	Fair	Good	Poor	Good.
Za------------------ Zaar	Fair	Fair	Fair	Good	Good	Good	Poor	Fair	Fair	Good	Poor	Fair.
Zb------------------ Zaar	Fair	Fair	Fair	Good	Good	Good	Poor	Very poor.	Fair	Good	Very poor.	Fair.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
Ba: Bates	Moderate: depth to rock.	Slight	Moderate: depth to rock.	Slight	Slight	Moderate: thin layer.
Bc, Bd: Bates	Moderate: depth to rock.	Slight	Moderate: depth to rock.	Moderate: slope.	Slight	Moderate: thin layer.
Bh*:						
Bolivar	Moderate: depth to rock, slope.	Moderate: shrink-swell, slope.	Moderate: depth to rock, slope, shrink-swell.	Severe: slope.	Moderate: low strength, slope, shrink-swell.	Moderate: slope, thin layer.
Hector	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: thin layer.
Ca: Catoosa	Severe: depth to rock.	Moderate: shrink-swell, depth to rock.	Severe: depth to rock.	Moderate: shrink-swell, depth to rock.	Severe: low strength.	Moderate: thin layer.
Cs: Clareson	Severe: depth to rock, large stones.	Severe: large stones.	Severe: depth to rock, large stones.	Severe: large stones.	Severe: low strength, large stones.	Severe: large stones.
De, Df: Dennis	Moderate: too clayey, wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.	Slight.
Ec*:						
Eram	Severe: wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell, slope.	Severe: low strength, shrink-swell.	Moderate: slope, thin layer.
Collinsville	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: thin layer.
Ke: Kenoma	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.	Slight.
La: Lanton	Severe: wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: low strength, floods.	Moderate: wetness.
Le: Leanna	Severe: wetness.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: low strength, wetness, floods.	Severe: wetness.
Ma: Mason	Slight	Severe: floods.	Severe: floods.	Severe: floods.	Severe: low strength.	Slight.
No: Nowata	Severe: depth to rock.	Moderate: shrink-swell, depth to rock.	Severe: depth to rock.	Moderate: shrink-swell, slope, depth to rock.	Moderate: depth to rock, shrink-swell.	Moderate: thin layer.
Or*. Orthents						
Os: Osage	Severe: wetness.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: low strength, wetness, floods.	Severe: wetness, too clayey.

See footnote at end of table.

TABLE 12.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Ba, Bc, Bd---------- Bates	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Bh*:					
Bolivar------------	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Hector-------------	Severe: depth to rock.	Severe: seepage, depth to rock, slope.	Severe: depth to rock, seepage.	Severe: depth to rock, seepage.	Poor: area reclaim, small stones.
Ca------------------ Catoosa	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim.
Cs------------------ Clareson	Severe: depth to rock, percs slowly, large stones.	Severe: depth to rock, large stones.	Severe: depth to rock, too clayey, large stones.	Severe: depth to rock.	Poor: area reclaim, too clayey, hard to pack.
De, Df-------------- Dennis	Severe: percs slowly, wetness.	Moderate: slope.	Severe: too clayey.	Moderate: wetness.	Poor: too clayey, hard to pack.
Ec*:					
Eram---------------	Severe: depth to rock, wetness, percs slowly.	Severe: depth to rock, slope.	Severe: depth to rock, too clayey.	Severe: depth to rock.	Poor: area reclaim, too clayey, hard to pack.
Collinsville-------	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock, seepage.	Severe: depth to rock.	Poor: area reclaim.
Ke------------------ Kenoma	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight-----------	Poor: too clayey, hard to pack.
La------------------ Lanton	Severe: floods, wetness, percs slowly.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Poor: wetness, thin layer.
Le------------------ Leanna	Severe: floods, wetness, percs slowly.	Severe: floods, wetness.	Severe: floods, wetness, too clayey.	Severe: floods, wetness.	Poor: too clayey, hard to pack, wetness.
Ma------------------ Mason	Severe: percs slowly.	Slight-----------	Moderate: floods, too clayey.	Moderate: floods.	Fair: too clayey.
No------------------ Nowata	Severe: depth to rock, percs slowly.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim, small stones.
Or*. Orthents					
Os------------------ Osage	Severe: floods, wetness, percs slowly.	Severe: floods, wetness.	Severe: floods, wetness, too clayey.	Severe: floods, wetness.	Poor: too clayey, hard to pack, wetness.

See footnote at end of table.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
Pa------------------ Parsons	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, wetness, shrink-swell.	Severe: wetness.
Pt*. Pits						
Rc*:						
Ringo--------------	Moderate: depth to rock, slope.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, slope.	Severe: low strength, shrink-swell.	Severe: too clayey.
Clareson-----------	Severe: depth to rock, large stones.	Severe: large stones.	Severe: depth to rock, large stones.	Severe: large stones.	Severe: low strength, large stones.	Severe: large stones.
Ta------------------ Tamaha	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, shrink-swell.	Moderate: wetness.
Ve------------------ Verdigris	Moderate: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Moderate: floods.
Vf------------------ Verdigris	Moderate: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.
Za, Zb-------------- Zaar	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, shrink-swell.	Severe: too clayey.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Pa: Parsons	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
Pt*. Pits					
Rc*:					
Ringo	Severe: depth to rock, percs slowly.	Severe: depth to rock, slope.	Severe: depth to rock, too clayey.	Severe: depth to rock.	Poor: area reclaim, too clayey, hard to pack.
Clareson	Severe: depth to rock, percs slowly, large stones.	Severe: depth to rock, large stones, slope.	Severe: depth to rock, too clayey, large stones.	Severe: depth to rock.	Poor: area reclaim, too clayey, hard to pack.
Ta: Tamaha	Severe: wetness, percs slowly.	Moderate: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
Ve, Vf: Verdigris	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Fair: too clayey.
Za: Zaar	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
Zb: Zaar	Severe: wetness, percs slowly.	Moderate: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," "poor," "probable," and "improbable." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Ba, Bc, Bd------------- Bates	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, small stones, thin layer.
Bh*:				
Bolivar---------------	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, small stones, thin layer.
Hector----------------	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones.
Ca-------------------- Catoosa	Poor: area reclaim, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, thin layer.
Cs-------------------- Clareson	Poor: area reclaim, low strength, large stones.	Improbable: excess fines, large stones.	Improbable: excess fines, large stones.	Poor: large stones.
De, Df---------------- Dennis	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, thin layer.
Ec*:				
Eram------------------	Poor: area reclaim, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Collinsville----------	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones.
Ke-------------------- Kenoma	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
La-------------------- Lanton	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, thin layer.
Le-------------------- Leanna	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
Ma-------------------- Mason	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
No-------------------- Nowata	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
Or*. Orthents				

See footnote at end of table.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Os--------------------- Osage	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
Pa--------------------- Parsons	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
Pt*. Pits				
Rc*: Ringo-----------------	Poor: area reclaim, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
Clareson-------------	Poor: area reclaim, low strength, large stones.	Improbable: excess fines, large stones.	Improbable: excess fines, large stones.	Poor: large stones.
Ta--------------------- Tamaha	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Ve, Vf---------------- Verdigris	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Za, Zb---------------- Zaar	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated]

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
Ba----------------- Bates	Moderate: seepage, depth to rock.	Severe: piping.	Deep to water	Depth to rock	Depth to rock	Depth to rock.
Bc, Bd------------ Bates	Moderate: seepage, depth to rock, slope.	Severe: piping.	Deep to water	Depth to rock, slope.	Depth to rock	Depth to rock.
Bh*:						
Bolivar----------	Severe: slope.	Severe: thin layer.	Deep to water	Soil blowing, depth to rock, slope.	Slope, depth to rock, soil blowing.	Slope, depth to rock.
Hector-----------	Severe: depth to rock.	Severe: piping.	Deep to water	Droughty, depth to rock, slope.	Depth to rock	Droughty, depth to rock.
Ca----------------- Catoosa	Moderate: seepage, depth to rock.	Severe: thin layer.	Deep to water	Depth to rock, rooting depth.	Depth to rock, erodes easily.	Erodes easily, depth to rock, rooting depth.
Cs----------------- Clareson	Moderate: depth to rock.	Severe: large stones.	Deep to water	Large stones, droughty, percs slowly.	Large stones, depth to rock.	Large stones, droughty.
De----------------- Dennis	Slight---------	Moderate: hard to pack, wetness.	Percs slowly---	Wetness, percs slowly, rooting depth.	Erodes easily, wetness, percs slowly.	Erodes easily, rooting depth, percs slowly.
Df----------------- Dennis	Moderate: slope.	Moderate: hard to pack, wetness.	Percs slowly, slope.	Wetness, percs slowly, rooting depth.	Erodes easily, wetness, percs slowly.	Erodes easily, rooting depth, percs slowly.
Ec*:						
Eram-------------	Severe: slope.	Moderate: thin layer, hard to pack, wetness.	Percs slowly, depth to rock, slope.	Wetness, percs slowly, depth to rock.	Slope, depth to rock, erodes easily.	Slope, erodes easily, depth to rock.
Collinsville-----	Severe: depth to rock.	Slight---------	Deep to water	Depth to rock, slope.	Depth to rock	Depth to rock.
Ke----------------- Kenoma	Slight---------	Severe: hard to pack.	Deep to water	Percs slowly, erodes easily.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
La----------------- Lanton	Slight---------	Severe: piping, wetness.	Percs slowly, floods.	Wetness, percs slowly, erodes easily.	Erodes easily, wetness.	Wetness, erodes easily, percs slowly.
Le----------------- Leanna	Slight---------	Severe: wetness.	Percs slowly, floods.	Wetness, percs slowly, erodes easily.	Erodes easily, wetness, percs slowly.	Wetness, erodes easily, percs slowly.
Ma----------------- Mason	Slight---------	Severe: piping.	Deep to water	Erodes easily	Erodes easily	Erodes easily.
No----------------- Nowata	Moderate: depth to rock, slope.	Severe: large stones.	Deep to water	Large stones, depth to rock, rooting depth.	Large stones, depth to rock, erodes easily.	Large stones, erodes easily, depth to rock.
Or*. Orthents						

See footnote at end of table.

TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
Os----------------- Osage	Slight---------	Severe: hard to pack, wetness.	Percs slowly, floods.	Wetness, droughty, slow intake.	Wetness, percs slowly.	Wetness, droughty, percs slowly.
Pa----------------- Parsons	Slight---------	Severe: wetness.	Percs slowly---	Wetness, percs slowly, erodes easily.	Erodes easily, wetness, percs slowly.	Wetness, erodes easily, percs slowly.
Pt*. Pits						
Rc*:						
Ringo-------------	Severe: slope.	Severe: thin layer.	Deep to water	Slow intake, percs slowly, depth to rock.	Slope, depth to rock, percs slowly.	Slope, depth to rock, percs slowly.
Clareson----------	Moderate: depth to rock.	Severe: large stones.	Deep to water	Large stones, droughty, percs slowly.	Large stones, depth to rock.	Large stones, droughty.
Ta----------------- Tamaha	Moderate: slope.	Moderate: hard to pack, wetness.	Percs slowly, slope.	Wetness, percs slowly, slope.	Erodes easily, wetness, percs slowly.	Wetness, erodes easily, percs slowly.
Ve, Vf------------ Verdigris	Moderate: seepage.	Moderate: piping.	Deep to water	Floods---------	Favorable------	Favorable.
Za----------------- Zaar	Slight---------	Moderate: hard to pack, wetness.	Percs slowly---	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
Zb----------------- Zaar	Moderate: slope.	Moderate: hard to pack, wetness.	Percs slowly, slope.	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--ENGINEERING INDEX PROPERTIES

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
Ba, Bc----------- Bates	0-12	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-100	80-100	55-90	20-40	3-15
	12-35	Loam, sandy loam, sandy clay loam.	ML, CL, SC, SM	A-4, A-6	0	85-100	85-100	80-100	45-85	25-40	3-15
	35	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Bd--------------- Bates	0-5	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	90-100	85-100	80-100	55-90	20-40	3-15
	5-23	Loam, sandy loam, sandy clay loam.	ML, CL, SC, SM	A-4, A-6	0	85-100	85-100	80-100	45-85	25-40	3-15
	23	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Bh*:											
Bolivar---------	0-12	Fine sandy loam	ML, SM	A-4	0	100	90-100	70-95	40-55	20-30	NP-5
	12-34	Loam, sandy clay loam, clay loam.	CL, SC	A-6	0-10	85-100	85-100	70-95	45-80	25-40	10-25
	34	Weathered bedrock	---	---	---	---	---	---	---	---	---
Hector----------	0-7	Fine sandy loam	SM, ML, SM-SC, CL-ML	A-4, A-2	0	80-100	80-100	80-100	30-65	<30	NP-6
	7-12	Fine sandy loam, gravelly fine sandy loam, gravelly loam.	SM, ML, GM, GM-GC	A-4, A-2	0-15	55-100	55-100	45-100	30-65	<30	NP-6
	12	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Ca--------------- Catoosa	0-14	Silt loam--------	CL	A-4, A-6	0	100	100	96-100	65-97	30-37	8-14
	14-36	Silty clay loam, clay loam.	CL	A-6, A-7	0	100	100	96-100	80-98	33-43	12-20
	36	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Cs--------------- Clareson	0-10	Stony silty clay loam.	CL	A-4, A-6	25-50	90-100	90-100	85-95	85-95	30-40	8-18
	10-15	Silty clay loam, flaggy silty clay loam.	CL	A-6, A-7	0-65	90-100	90-100	85-95	85-95	35-45	11-20
	15-32	Flaggy silty clay, flaggy silty clay loam.	CL, CH	A-7	50-85	85-100	85-100	80-95	80-95	41-60	18-35
	32	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
De, Df----------- Dennis	0-15	Silt loam--------	ML, CL, CL-ML	A-4, A-6	0	100	100	96-100	65-97	20-37	1-15
	15-22	Silty clay loam, clay loam.	CL	A-6, A-7	0	98-100	98-100	94-100	75-98	33-48	13-25
	22-60	Clay, silty clay, silty clay loam.	CL, CH	A-7, A-6	0	98-100	98-100	94-100	75-98	37-65	15-35
Ec*:											
Eram------------	0-10	Silty clay loam	CL	A-6, A-7	0	85-100	85-100	85-100	75-95	33-48	12-25
	10-30	Clay, silty clay, clay loam.	CL, CH	A-7, A-6	0	95-100	95-100	90-100	85-98	37-65	15-35
	30	Weathered bedrock	---	---	---	---	---	---	---	---	---
Collinsville----	0-14	Fine sandy loam	SM, SC, ML, CL	A-4	0-35	80-100	60-100	60-95	36-75	<30	NP-10
	14	Unweathered bedrock.	---	---	---	---	---	---	---	---	---

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification Unified	Classification AASHTO	Fragments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
Ke----------------- Kenoma	0-8	Silt loam--------	CL, CL-ML, ML	A-4, A-6	0	85-100	85-100	85-100	85-100	25-40	3-18
	8-50	Silty clay, clay	CH	A-7	0	85-100	85-100	85-100	85-100	50-75	30-48
	50-60	Silty clay, silty clay loam.	CL, CH	A-7	0	85-100	85-100	75-100	75-95	45-65	25-44
La----------------- Lanton	0-26	Silty clay loam	CL	A-4, A-6	0	100	95-100	90-100	80-95	25-38	8-15
	26-48	Silt loam, silty clay loam.	ML, CL	A-4, A-6	0	100	95-100	85-100	80-95	30-38	8-16
	48-60	Clay, silty clay, silty clay loam.	CH, CL	A-6, A-7	0	100	95-100	85-100	75-95	40-55	18-28
Le----------------- Leanna	0-13	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	100	95-100	85-100	25-40	5-20
	13-38	Silty clay, silty clay loam, clay.	CH, CL	A-7	0	100	100	95-100	90-100	45-65	25-40
	38-60	Silty clay loam, silty clay.	CL, CH	A-6, A-7	0	100	100	95-100	90-100	35-55	20-35
Ma----------------- Mason	0-17	Silt loam--------	ML, CL, CL-ML	A-4, A-6	0	100	100	96-100	65-98	20-35	1-13
	17-60	Silty clay loam, clay loam, silt loam.	CL	A-6, A-4, A-7	0	98-100	98-100	96-100	65-98	30-43	9-20
No----------------- Nowata	0-15	Silt loam--------	CL	A-4, A-6	0-15	85-100	80-100	75-95	70-95	30-37	8-13
	15-36	Gravelly silty clay loam, very gravelly silty clay loam, cherty silty clay loam.	GC, GP-GC	A-2, A-6, A-7	0-65	15-50	10-50	10-45	5-40	33-42	12-19
	36	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Or*. Orthents											
Os----------------- Osage	0-13	Silty clay-------	CH	A-7	0	100	100	100	95-100	50-75	30-55
	13-60	Silty clay, clay	CH	A-7	0	100	100	100	95-100	50-80	30-55
Pa----------------- Parsons	0-15	Silt loam--------	ML, CL, CL-ML	A-4, A-6	0	100	96-100	96-100	80-97	20-37	1-12
	15-60	Clay loam, silty clay loam, silty clay.	CL, CH	A-6, A-7	0	100	96-100	96-100	80-99	37-70	15-40
Pt*. Pits											
Rc*: Ringo-------------	0-30	Silty clay-------	CH, CL	A-7	0	100	100	95-100	90-100	40-65	20-40
	30	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Clareson---------	0-10	Stony silty clay loam.	CL	A-4, A-6	25-50	90-100	90-100	85-95	85-95	30-40	8-18
	10-15	Silty clay loam, flaggy silty clay loam.	CL	A-6, A-7	0-65	90-100	90-100	85-95	85-95	35-45	11-20
	15-32	Flaggy silty clay, flaggy silty clay loam.	CL, CH	A-7	50-85	85-100	85-100	80-95	80-95	41-60	18-35
	32	Unweathered bedrock.	---	---	---	---	---	---	---	---	---

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Ta---------------- Tamaha	0-7	Silt loam---------	CL, ML, CL-ML	A-4, A-6	0	98-100	98-100	96-100	65-97	22-37	2-14
	7-12	Silt loam, clay loam, silty clay loam.	CL	A-4, A-6, A-7	0	95-100	95-100	95-100	80-98	30-42	8-19
	12-60	Silty clay loam, silty clay, clay.	CL, CH	A-6, A-7	0	98-100	98-100	96-100	80-99	37-65	15-35
Ve, Vf----------- Verdigris	0-22	Silt loam---------	CL, CL-ML, ML	A-4, A-6	0	100	100	95-100	65-100	22-38	2-13
	22-60	Silt loam, silty clay loam.	CL	A-4, A-6, A-7	0	100	100	95-100	80-100	30-45	8-23
Za, Zb----------- Zaar	0-15	Silty clay--------	CH, CL	A-7	0	100	100	95-100	90-100	45-70	20-40
	15-48	Silty clay, clay	CH	A-7	0	100	100	95-100	90-100	50-70	25-40
	48-60	Silty clay, clay, silty clay loam.	CH, CL	A-7	0	100	100	95-100	90-100	40-65	15-40

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

[The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Clay <2mm	Moist bulk density	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	G/cm^3	In/hr	In/in	pH	Mmhos/cm					Pct
Ba, Bc----------- Bates	0-12	15-27	1.40-1.50	0.6-2.0	0.20-0.24	5.1-6.5	<2	Low--------	0.28	4	6	1-4
	12-35	18-35	1.50-1.60	0.6-2.0	0.15-0.19	5.1-6.5	<2	Low--------	0.28			
	35	---	---	---	---	---	---	-----------	----			
Bd--------------- Bates	0-5	15-27	1.40-1.50	0.6-2.0	0.20-0.24	5.1-6.5	<2	Low--------	0.28	4	6	1-2
	5-23	18-35	1.50-1.60	0.6-2.0	0.15-0.19	5.1-6.5	<2	Low--------	0.28			
	23	---	---	---	---	---	---	-----------	----			
Bh*:												
Bolivar----------	0-12	12-18	1.20-1.45	2.0-6.0	0.16-0.18	5.1-6.0	<2	Low--------	0.24	4	3	.5-2
	12-34	20-35	1.30-1.50	0.6-2.0	0.12-0.16	4.5-6.0	<2	Moderate	0.32			
	34	---	---	---	---	---	---	-----------	----			
Hector-----------	0-7	5-20	1.30-1.65	2.0-6.0	0.10-0.14	5.1-6.5	<2	Low--------	0.24	2	3	.5-2
	7-12	5-20	1.30-1.65	2.0-6.0	0.08-0.15	4.5-5.5	<2	Low--------	0.24			
	12	---	---	---	---	---	---	-----------	----			
Ca--------------- Catoosa	0-14	10-20	1.30-1.50	0.6-2.0	0.15-0.24	5.6-6.5	<2	Low--------	0.32	3	6	1-2
	14-36	27-35	1.45-1.75	0.6-2.0	0.15-0.22	5.1-7.3	<2	Moderate	0.32			
	36	---	---	---	---	---	---	-----------	----			
Cs--------------- Clareson	0-10	15-30	1.20-1.30	0.6-2.0	0.09-0.17	5.6-7.3	<2	Moderate	0.24	2	8	1-4
	10-15	27-40	1.30-1.40	0.2-2.0	0.09-0.21	5.6-7.3	<2	Moderate	0.24			
	15-32	35-50	1.35-1.45	0.06-0.6	0.04-0.07	5.6-7.3	<2	Moderate	0.24			
	32	---	---	---	---	---	---	-----------	----			
De, Df----------- Dennis	0-15	10-27	1.30-1.55	0.6-2.0	0.15-0.20	5.1-6.0	<2	Low--------	0.37	4	6	1-3
	15-22	27-35	1.45-1.70	0.2-0.6	0.15-0.20	4.5-6.0	<2	Moderate	0.37			
	22-60	35-55	1.35-1.65	0.06-0.2	0.15-0.20	5.1-8.4	<2	High-------	0.37			
Ec*:												
Eram-------------	0-10	27-32	1.30-1.60	0.2-0.6	0.15-0.19	5.6-6.5	<2	Moderate	0.37	3	7	1-3
	10-30	35-55	1.45-1.75	0.06-0.2	0.14-0.18	5.1-7.3	<2	High-------	0.37			
	30	---	---	---	---	---	---	-----------	----			
Collinsville-----	0-14	5-20	1.30-1.65	2.0-6.0	0.12-0.16	5.1-6.5	<2	Low--------	0.20	2	3	1-2
	14	---	---	---	---	---	---	-----------	----			
Ke--------------- Kenoma	0-8	18-29	1.35-1.45	0.2-0.6	0.22-0.24	5.1-6.5	<2	Low--------	0.43	4	6	2-4
	8-50	40-60	1.40-1.50	<0.06	0.10-0.15	5.1-7.8	<2	High-------	0.32			
	50-60	30-50	1.35-1.45	0.06-0.2	0.18-0.20	6.1-8.4	<4	High-------	0.32			
La--------------- Lanton	0-26	27-35	1.30-1.40	0.6-2.0	0.18-0.22	6.1-7.3	<2	Low--------	0.32	5	7	2-4
	26-48	24-35	1.35-1.50	0.2-0.6	0.17-0.22	6.1-7.3	<2	Low--------	0.43			
	48-60	35-45	1.45-1.55	0.06-0.6	0.12-0.18	6.1-7.3	<2	Moderate	0.32			
Le--------------- Leanna	0-13	15-30	1.25-1.35	0.2-0.6	0.22-0.24	5.1-6.5	<2	Low--------	0.37	5	6	1-4
	13-38	35-50	1.35-1.50	<0.06	0.11-0.18	5.1-6.5	<2	High-------	0.37			
	38-60	27-45	1.35-1.45	0.06-0.2	0.11-0.20	5.6-7.3	<2	High-------	0.37			
Ma--------------- Mason	0-17	20-30	1.30-1.60	0.6-2.0	0.16-0.20	5.1-7.3	<2	Low--------	0.32	5	6	1-4
	17-60	20-35	1.40-1.70	0.2-0.6	0.16-0.20	4.5-7.8	<2	Moderate	0.32			
No--------------- Nowata	0-15	15-27	1.30-1.50	0.6-2.0	0.15-0.22	5.6-6.5	<2	Low--------	0.32	3	6	1-3
	15-36	27-35	1.45-1.75	0.2-0.6	0.08-0.12	5.6-7.3	<2	Moderate	0.32			
	36	---	---	---	---	---	---	-----------	----			
Or*. Orthents												
Os--------------- Osage	0-13	40-50	1.40-1.60	<0.06	0.12-0.14	5.1-7.3	<2	Very high	0.28	5	4	1-4
	13-60	40-60	1.50-1.70	<0.06	0.08-0.12	5.6-7.8	<2	Very high	0.28			

See footnote at end of table.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay <2mm	Moist bulk density	Permea- bility	Available water capacity	Soil reaction	Salinity	Shrink- swell potential	Erosion factors K	Erosion factors T	Wind erodi- bility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH	Mmhos/cm					Pct
Pa---------------- Parsons	0-15	15-25	1.30-1.50	0.6-2.0	0.16-0.24	5.1-6.5	<2	Low--------	0.43	4	6	.5-1
	15-60	35-60	1.40-1.70	<0.6	0.14-0.22	5.1-7.8	<2	High------	0.43			
Pt*. Pits												
Rc*:												
Ringo------------	0-30	35-50	1.35-1.50	<0.06	0.13-0.21	6.1-8.4	<2	High------	0.28	3	4	2-4
	30	---	---	---	---	---	---	----------	----			
Clareson---------	0-10	15-30	1.20-1.30	0.6-2.0	0.09-0.17	5.6-7.3	<2	Moderate	0.24	2	8	1-4
	10-15	27-40	1.30-1.40	0.2-2.0	0.09-0.21	5.6-7.3	<2	Moderate	0.24			
	15-32	35-50	1.35-1.45	0.06-0.6	0.04-0.07	5.6-7.3	<2	Moderate	0.24			
	32	---	---	---	---	---	---	----------	----			
Ta---------------- Tamaha	0-7	10-25	1.30-1.55	0.6-2.0	0.15-0.24	4.5-6.5	<2	Low--------	0.43	5	6	<1
	7-12	20-35	1.40-1.70	0.2-0.6	0.15-0.22	4.5-6.0	<2	Moderate	0.43			
	12-60	35-45	1.35-1.65	<0.06	0.14-0.20	5.1-7.3	<2	High------	0.43			
Ve, Vf----------- Verdigris	0-22	15-27	1.30-1.40	0.6-2.0	0.20-0.24	5.6-7.3	<2	Low--------	0.32	5	6	2-4
	22-60	18-35	1.40-1.65	0.6-2.0	0.17-0.22	5.6-7.3	<2	Moderate	0.32			
Za, Zb----------- Zaar	0-15	35-60	1.20-1.30	<0.06	0.12-0.21	5.6-7.3	<2	High------	0.28	5	4	2-4
	15-48	40-60	1.35-1.50	<0.06	0.11-0.18	6.1-8.4	<2	High------	0.28			
	48-60	35-50	1.35-1.50	<0.06	0.10-0.18	6.6-8.4	<2	High------	0.28			

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--SOIL AND WATER FEATURES

[The definitions of "flooding" and "water table" in the text explain terms such as "rare," "brief," "apparent," and "perched." The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern]

Soil name and map symbol	Hydrologic group	Flooding: Frequency	Flooding: Duration	Flooding: Months	High water table: Depth	High water table: Kind	High water table: Months	Bedrock: Depth	Bedrock: Hardness	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete
					Ft			In			
Ba, Bc, Bd: Bates	B	None	---	---	>6.0	---	---	20-40	Soft	Low	Moderate.
Bh*:											
Bolivar	B	None	---	---	>6.0	---	---	20-40	Soft	Low	Moderate.
Hector	D	None	---	---	>6.0	---	---	10-20	Hard	Low	Moderate.
Ca: Catoosa	B	None	---	---	>6.0	---	---	20-40	Hard	Moderate	Moderate.
Cs: Clareson	C	None	---	---	>6.0	---	---	20-40	Hard	High	Moderate.
De, Df: Dennis	C	None	---	---	2.0-3.0	Perched	Dec-Apr	>60	---	High	Moderate.
Ec*:											
Eram	C	None	---	---	2.0-3.0	Perched	Dec-Apr	20-40	Soft	High	Moderate.
Collinsville	C	None	---	---	>6.0	---	---	4-20	Hard	Low	Moderate.
Ke: Kenoma	D	None	---	---	>6.0	---	---	>60	---	High	Moderate.
La: Lanton	D	Occasional	Very brief	Jan-May	1.0-2.0	Apparent	Dec-May	>60	---	High	Low.
Le: Leanna	D	Occasional	Very brief	Jan-Dec	0.5-2.0	Perched	Dec-Jun	>60	---	High	Moderate.
Ma: Mason	B	Rare	---	---	>6.0	---	---	>60	---	Moderate	Moderate.
No: Nowata	B	None	---	---	>6.0	---	---	20-40	Hard	Moderate	Moderate.
Or*. Orthents											
Os: Osage	D	Occasional	Brief to long.	Nov-May	0-1.0	Perched	Nov-May	>60	---	High	Moderate.
Pa: Parsons	D	None	---	---	0.5-1.5	Perched	Dec-Apr	>60	---	High	Moderate.
Pt*. Pits											
Rc*:											
Ringo	D	None	---	---	>6.0	---	---	20-40	Soft	High	Low.
Clareson	C	None	---	---	>6.0	---	---	20-40	Hard	High	Moderate.
Ta: Tamaha	C	None	---	---	1.0-2.0	Perched	Nov-Apr	>60	---	High	High.
Ve: Verdigris	B	Occasional	Very brief	Dec-Jun	>6.0	---	---	>60	---	Low	Low.
Vf: Verdigris	B	Frequent	Very brief	Dec-Jun	>6.0	---	---	>60	---	Low	Low.
Za, Zb: Zaar	D	None	---	---	1.0-2.0	Perched	Dec-Apr	>60	---	High	Moderate.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 18.--ENGINEERING INDEX TEST DATA

Soil name, report number, horizon, and depth in inches	Classification		Grain-size distribution*							Liquid limit	Plasticity index	Moisture density**	
			Percentage passing sieve--				Percentage smaller than--						
	AASHTO	Unified	No. 4	No. 10	No. 40	No. 200	.02 mm	.005 mm	.002 mm			Max. dry density	Optimum moisture
										Pct		Lb/cu ft	Pct
Bates loam: (S76KS-011-018)													
A1------- 0 to 12	A-4(02)	CL	100	100	97	58	41	14	6	28	8	106	16
B2t------20 to 28	A-4(04)	CL	100	100	98	63	47	31	24	28	10	108	17
B3-------28 to 35	A-4(02)	SC	100	100	92	49	35	25	19	28	9	109	15
Parsons silt loam: (S77KS-011-011)													
Ap------- 0 to 7	A-4(10)	ML	100	100	98	91	62	20	8	35	10	95	20
B22t-----20 to 27	A-7-6(31)	CH	100	100	99	96	84	60	49	55	27	91	26
C--------40 to 60	A-7-6(21)	CL	100	100	98	91	70	41	28	43	22	101	20
Zaar silty clay: (S77KS-011-010)													
A12-------7 to 15	A-7-6(27)	CL	100	100	99	97	76	42	28	49	24	97	22
B22------24 to 36	A-7-6(38)	CH	100	100	99	96	81	45	24	58	35	102	21
C--------48 to 60	A-7-6(29)	CL-CH	100	100	99	96	79	42	22	50	27	101	21

* Grain-size distribution according to AASHTO Designation T 88 72, with the following variations: (1) all material is crushed in a laboratory steel-jawed crusher; (2) the sample is not soaked prior to dispersion; (3) dispersing time is 5 minutes at 7 p.s.i. using an Iowa air tube; and (4) AASHTO T 133 74 is followed except for sample size to obtain SpG for the hydrometer analysis. Results by this procedure can differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHTO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes.

** Moisture density according to AASHTO Designation T 99 74, Method A, with the following variations: (1) all material is crushed in a laboratory steel-jawed crusher after it is dried, and (2) no time is allowed for moisture to disperse after it is mixed with the soil material.

TABLE 19.--CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Bates	Fine-loamy, siliceous, thermic Typic Argiudolls
Bolivar	Fine-loamy, mixed, thermic Ultic Hapludalfs
Catoosa	Fine-silty, mixed, thermic Typic Argiudolls
Clareson	Clayey-skeletal, mixed, thermic Typic Argiudolls
Collinsville	Loamy, siliceous, thermic Lithic Hapludolls
Dennis	Fine, mixed, thermic Aquic Paleudolls
Eram	Fine, mixed, thermic Aquic Argiudolls
Hector	Loamy, siliceous, thermic Lithic Dystrochrepts
Kenoma	Fine, montmorillonitic, thermic Vertic Argiudolls
Lanton	Fine-silty, mixed, thermic Cumulic Haplaquolls
Leanna	Fine, mixed, thermic Typic Argialbolls
Mason	Fine-silty, mixed, thermic Typic Argiudolls
Nowata	Loamy-skeletal, mixed, thermic Typic Argiudolls
Orthents	Loamy-skeletal and clayey-skeletal, mixed, nonacid, thermic Udorthents
Osage	Fine, montmorillonitic, thermic Vertic Haplaquolls
*Parsons	Fine, mixed, thermic Mollic Albaqualfs
Ringo	Fine, mixed, thermic Entic Hapludolls
Tamaha	Fine, mixed, thermic Aquic Paleudalfs
Verdigris	Fine-silty, mixed, thermic Cumulic Hapludolls
Zaar	Fine, montmorillonitic, thermic Vertic Hapludolls

* A taxadjunct to the series. See the text for a description of those characteristics of the soil that are outside the range of the series.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1981 -326-687/66

NRCS Accessibility Statement

This document is not accessible by screen-reader software. The Natural Resources Conservation Service (NRCS) is committed to making its information accessible to all of its customers and employees. If you are experiencing accessibility issues and need assistance, please contact our Helpdesk by phone at 1-800-457-3642 or by e-mail at ServiceDesk-FTC@ftc.usda.gov. For assistance with publications that include maps, graphs, or similar forms of information, you may also wish to contact our State or local office. You can locate the correct office and phone number at http://offices.sc.egov.usda.gov/locator/app.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
KANSAS AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

BOURBON COUNTY, KANSAS

Scale 1:190,080

1 0 1 2 3 4 Miles

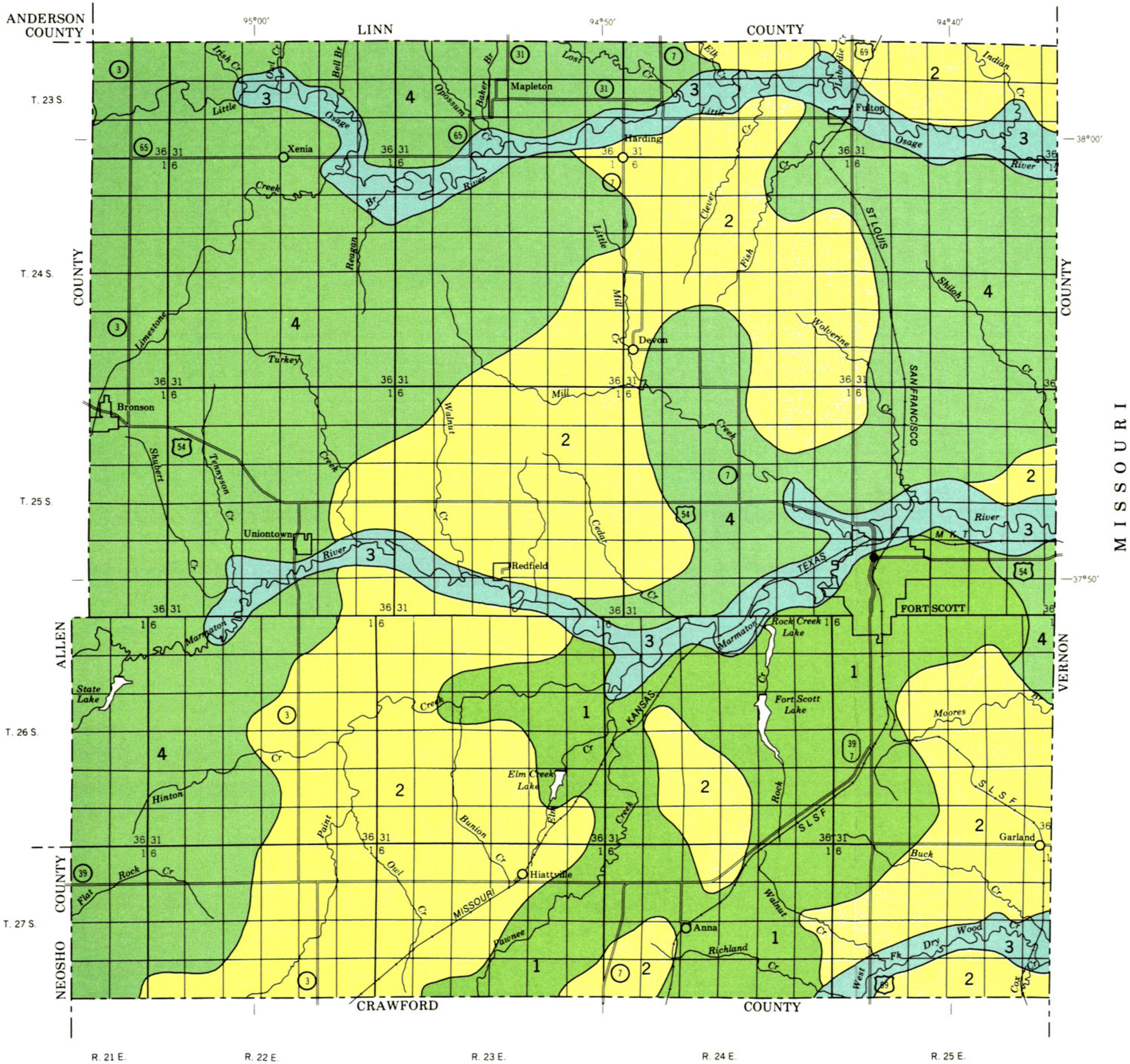
1 0 1 2 3 4 5 6 Kilometers

N

SOIL LEGEND

1	Clareson-Catoosa association: Moderately deep, nearly level and gently sloping, well drained soils that have a silty clay and silty clay loam subsoil; on uplands
2	Dennis-Kenoma association: Deep, gently sloping and moderately sloping, moderately well drained soils that have a silty clay and silty clay loam subsoil; on uplands
3	Verdigris-Lanton association: Deep, nearly level, well drained and somewhat poorly drained soils that have a silt loam and silty clay loam subsoil; on flood plains
4	Zaar-Catoosa-Clareson association: Deep and moderately deep, nearly level to strongly sloping, somewhat poorly drained and well drained soils that have a silty clay and silty clay loam subsoil; on uplands

Compiled 1980

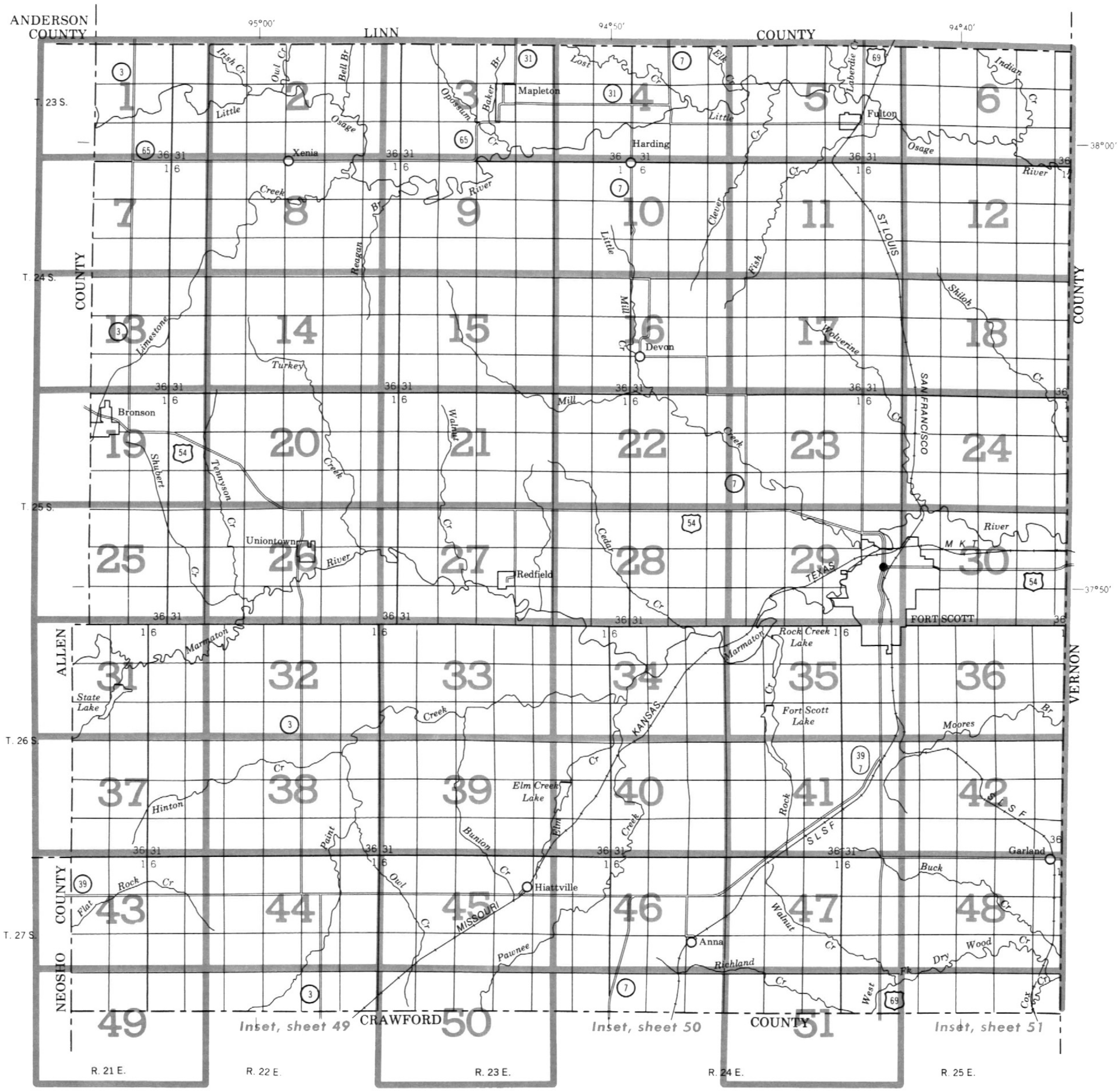


Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

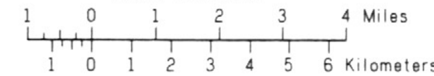
N



INDEX TO MAP SHEETS

BOURBON COUNTY, KANSAS

Scale 1:190,080



Original text from each individual map sheet read:
This map is compiled on 1977 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

SOIL LEGEND

SYMBOL	NAME
Ba	Bates loam, 1 to 4 percent slopes
Bc	Bates loam, 4 to 7 percent slopes
Bd	Bates loam, 4 to 7 percent slopes, eroded
Bh	Bolivar-Hector fine sandy loams, 5 to 15 percent slopes
Ca	Catoosa silt loam
Cs	Clareson stony silty clay loam, 1 to 4 percent slopes
De	Dennis silt loam, 1 to 3 percent slopes
Df	Dennis silt loam, 3 to 6 percent slopes
Ec	Eram-Collinsville complex, 5 to 12 percent slopes
Ke	Kenoma silt loam, 1 to 3 percent slopes
La	Lanton silty clay loam
Le	Leanna silt loam
Ma	Mason silt loam
No	Nowata silt loam, 3 to 5 percent slopes
Or	Orthents, hilly
Os	Osage silty clay
Pa	Parsons silt loam
Pt	Pits, quarries
Rc	Ringo-Clareson complex, 9 to 15 percent slopes
Ta	Tamaha silt loam, 1 to 5 percent slopes
Ve	Verdigris silt loam
Vf	Verdigris silt loam, channeled
Za	Zaar silty clay, 0 to 2 percent slopes
Zb	Zaar silty clay, 2 to 6 percent slopes

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline & neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, oilfield, cemetery, or flood pool — Davis Airstrip; FLOOD POOL LINE

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEMS & DESIGNATIONS

- Interstate — 79
- Federal — 410
- State — 52
- County, farm or ranch — 378

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or small — water; w

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label) — Indian Mound
- Located object (label) — Tower
- Tank (label) — GAS
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label) — CANAL
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial — water; w
- Intermittent — int; i

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS — Ca; Zb

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

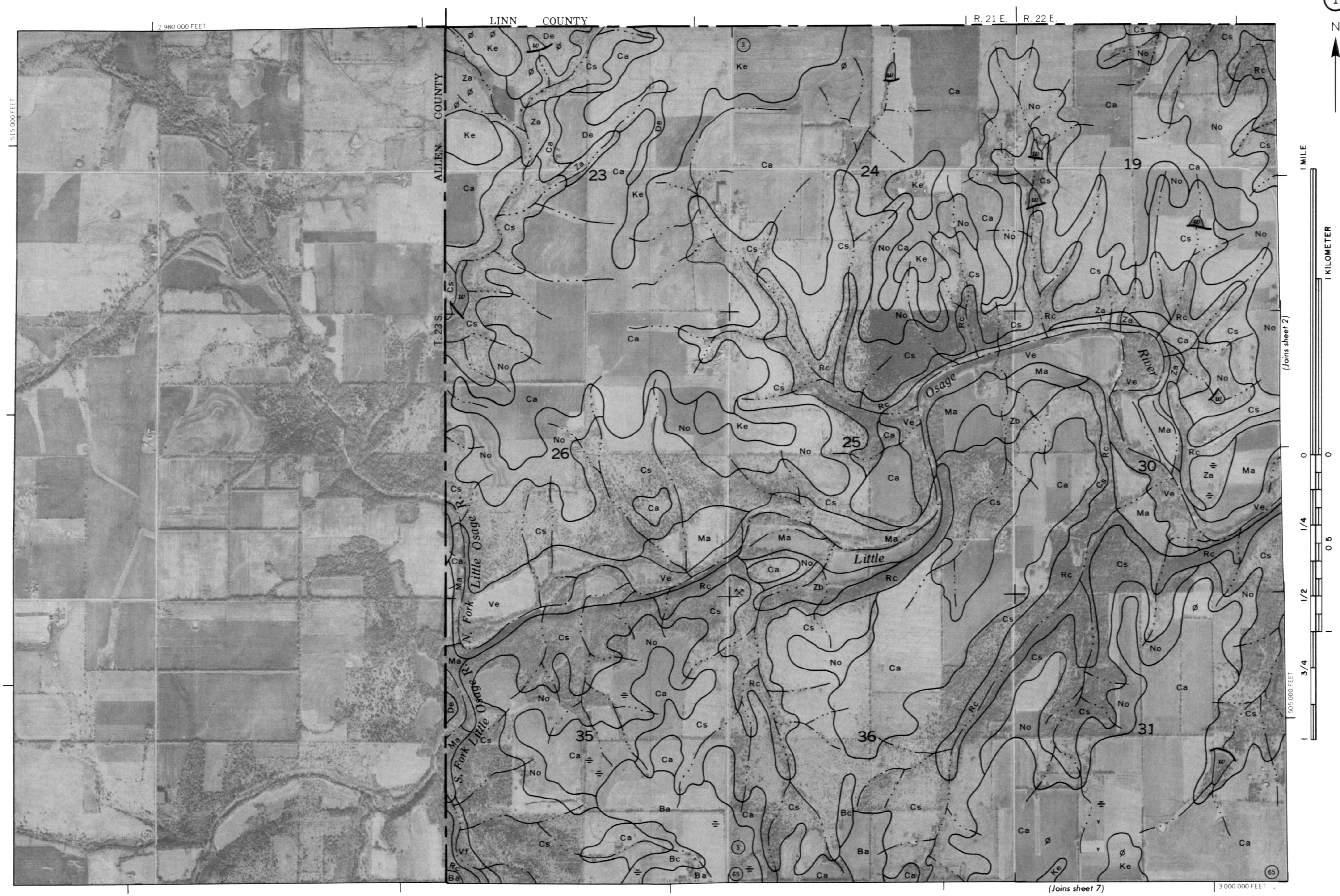
GULLY

DEPRESSION OR SINK

SOIL SAMPLE SITE (normally not shown) — S

MISCELLANEOUS

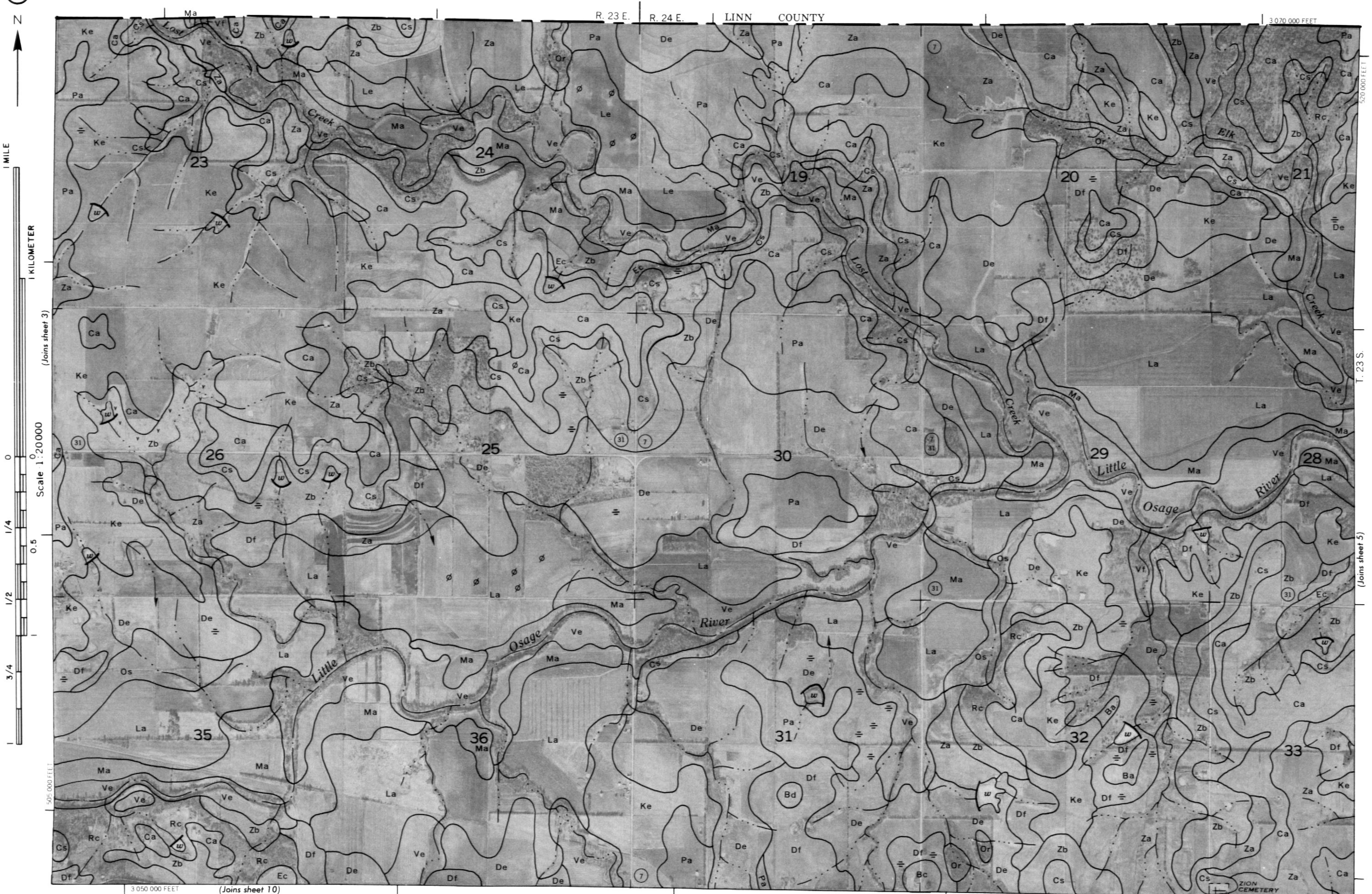
- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot
- Borrow area


LINN COUNTY
ALLEN COUNTY
R. 21 E.
R. 22 E.
T. 23 S.
2 980 000 FEET
515 000 FEET
505 000 FEET
3 000 000 FEET
(Joins sheet 2)
(Joins sheet 7)
N
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
1
0
0.5
1
Scale 1:20 000
23
24
19
26
25
30
35
36
31
Osage River
Little Osage R.
N. Fork Little Osage R.
S. Fork Little Osage R.

②

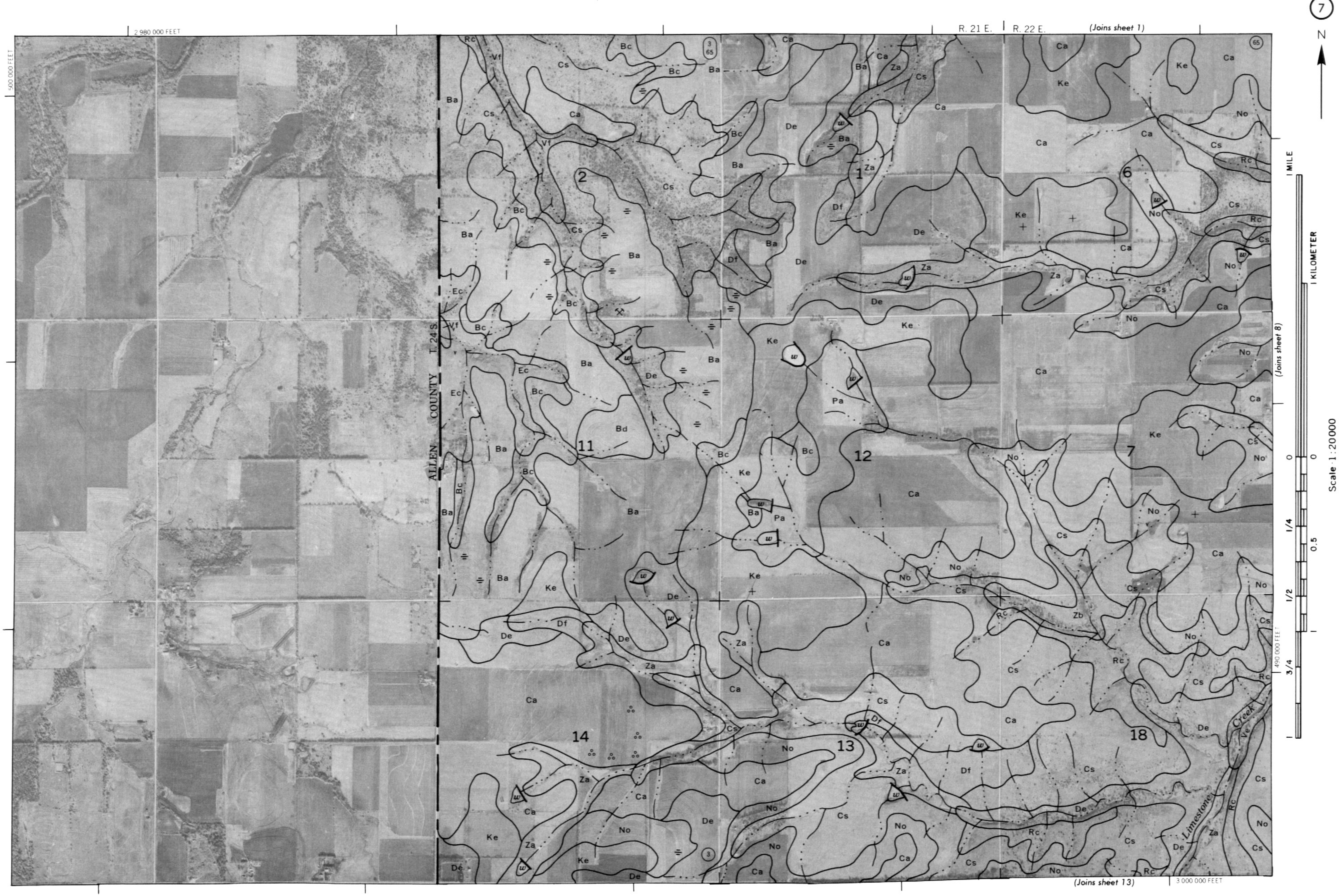
BOURBON COUNTY, KANSAS — SHEET NUMBER 2

BOURBON COUNTY, KANSAS — SHEET NUMBER 3


R. 23 E.
R. 24 E.
LINN COUNTY
3 070 000 FEET
520 000 FEET
T. 23 S.
(Joins sheet 3)
(Joins sheet 5)
(Joins sheet 10)
3 050 000 FEET
505 000 FEET
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5
Lost Creek
Elk Creek
Little Osage River
ZION CEMETERY
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36


5
N
LINN COUNTY
R. 24 E.
R. 25 E.
T. 23 S.
(Joins sheet 4)
(Joins sheet 6)
(Joins sheet 11)
3 075 000 FEET
3 095 000 FEET
520 000 FEET
510 000 FEET
Osage River
Little Osage River
Laberdie Creek
West Laberdie Creek
East Laberdie Creek
Elk Cr
Fish Creek
Clever Creek
Fulton
FAIRVIEW CEMETERY
ST. MICHAELS CEMETERY
SHAFFER CEMETERY
ST. LOUIS SAN FRANCISCO
water
1 MILE
1 KILOMETER
Scale 1:20000

BOURBON COUNTY, KANSAS — SHEET NUMBER 6

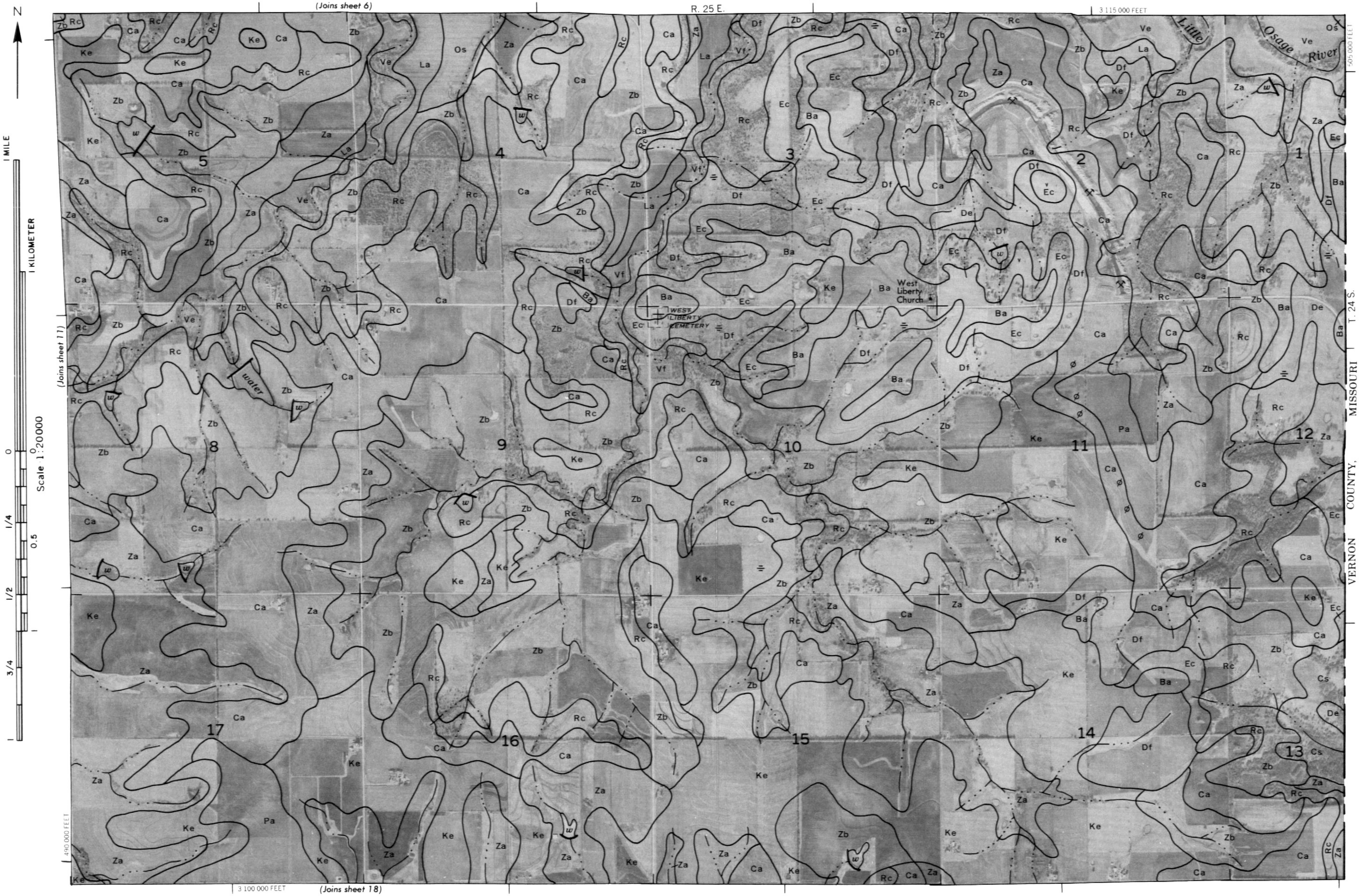

7
N
R. 21 E.
R. 22 E.
(Joins sheet 1)
(Joins sheet 8)
(Joins sheet 13)
ALLEN COUNTY
T. 24 S.
Limestone Creek
2 980 000 FEET
3 000 000 FEET
500 000 FEET
490 000 FEET
1 MILE
1 KILOMETER
Scale 1:20000

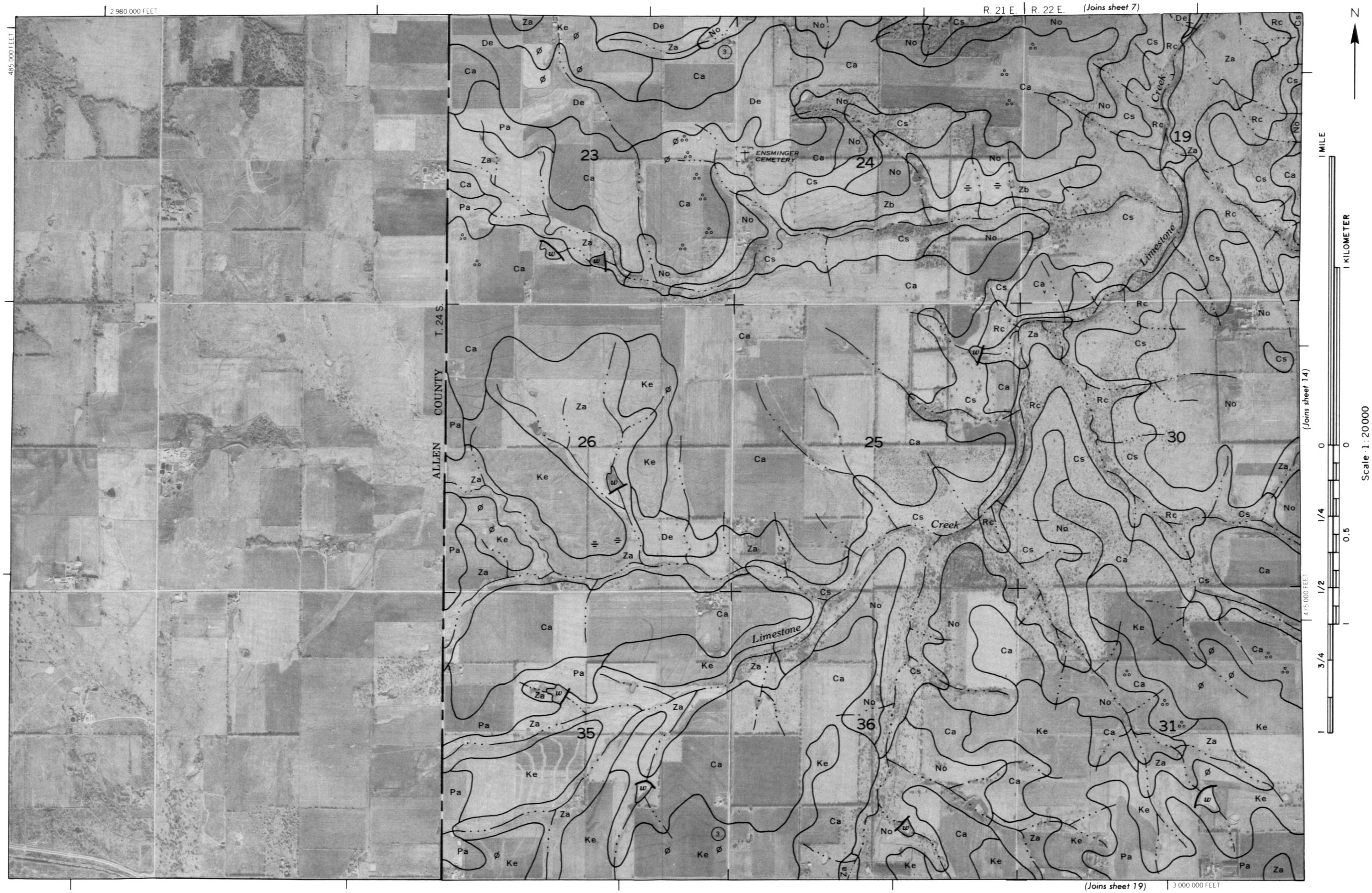

N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0
0.5
(Joins sheet 2)
R. 22 E.
3 025 000 FEET
500 000 FEET
T. 24 S.
(Joins sheet 9)
(Joins sheet 7)
490 000 FEET
3 005 000 FEET
(Joins sheet 14)
Xenia
WINDLE CEMETERY
Little Osage River
Limestone Creek
Limestone
Reagan Br.
Reagan Branch
Reagan
65
1
2
3
4
5
8
9
10
11
12
13
14
15
16
17

BOURBON COUNTY, KANSAS — SHEET NUMBER 9

BOURBON COUNTY, KANSAS — SHEET NUMBER 10


3 075 000 FEET
R. 24 E.
R. 25 E.
(Joins sheet 5)
T. 24 S.
500 000 FEET
(Joins sheet 10)
(Joins sheet 12)
(Joins sheet 17)
490 000 FEET
3 095 000 FEET
Clever Creek
Fish Creek
ST. LOUIS SAN FRANCISCO
GLENDALE CEMETERY
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5


N
(Joins sheet 6)
R. 25 E.
3 115 000 FEET
505 000 FEET
Little Osage River
West Liberty Church
WEST LIBERTY CEMETERY
water
T. 24 S.
MISSOURI
VERNON COUNTY,
(Joins sheet 11)
(Joins sheet 18)
3 100 000 FEET
490 000 FEET
1 MILE
1 KILOMETER
Scale 1:20000

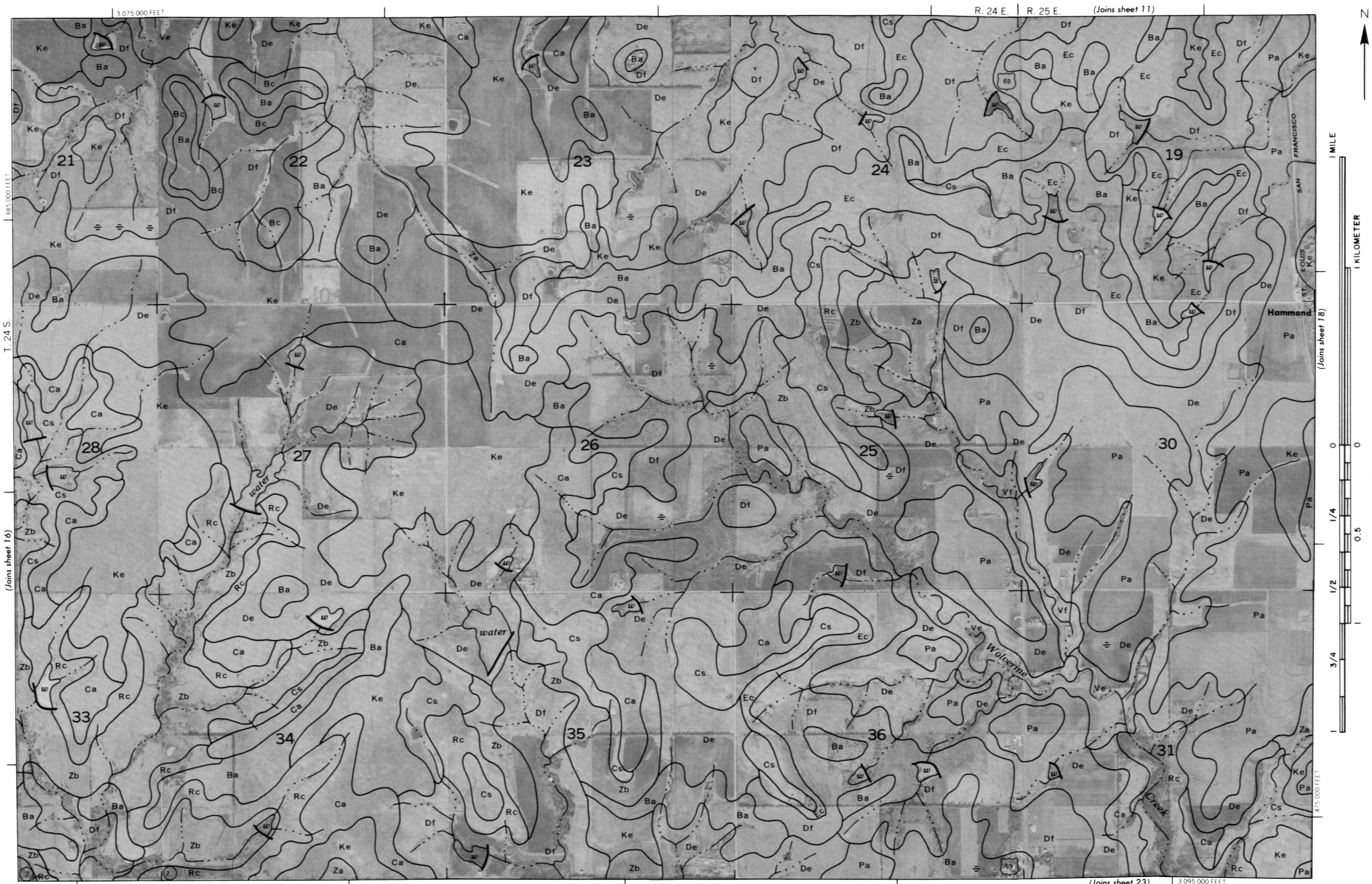

2 980 000 FEET
485 000 FEET
R. 21 E.
R. 22 E.
(Joins sheet 7)
(Joins sheet 14)
(Joins sheet 19)
475 000 FEET
3 000 000 FEET
T. 24 S.
ALLEN COUNTY
N
ENSMINGER CEMETERY
Limestone
Creek
23
24
19
26
25
30
35
36
31
1 MILE
1 KILOMETER
Scale 1 : 20000
0
1/4
1/2
3/4
1
0.5
Ca
Cs
De
Ke
No
Pa
Rc
Za
Zb


N
(Joins sheet 8)
R. 22 E.
3 025 000 FEET
485 000 FEET
(Joins sheet 13)
(Joins sheet 15)
(Joins sheet 20)
3 005 000 FEET
475 000 FEET
T. 24 S.
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36
Dry Ridge Church
Turkey
Creek
Dyer
Creek
Reagan
Branch
Ca
Cs
Rc
No
Ke
Pa
Za
Zb
Ve
Ma
w


15
N
R. 22 E.
R. 23 E.
3 030 000 FEET
(Joins sheet 9)
485 000 FEET
T. 24 S.
(Joins sheet 14)
(Joins sheet 16)
(Joins sheet 21)
475 000 FEET
3 050 000 FEET
Berlin
Mill Creek
1 MILE
1 KILOMETER
Scale 1:20000

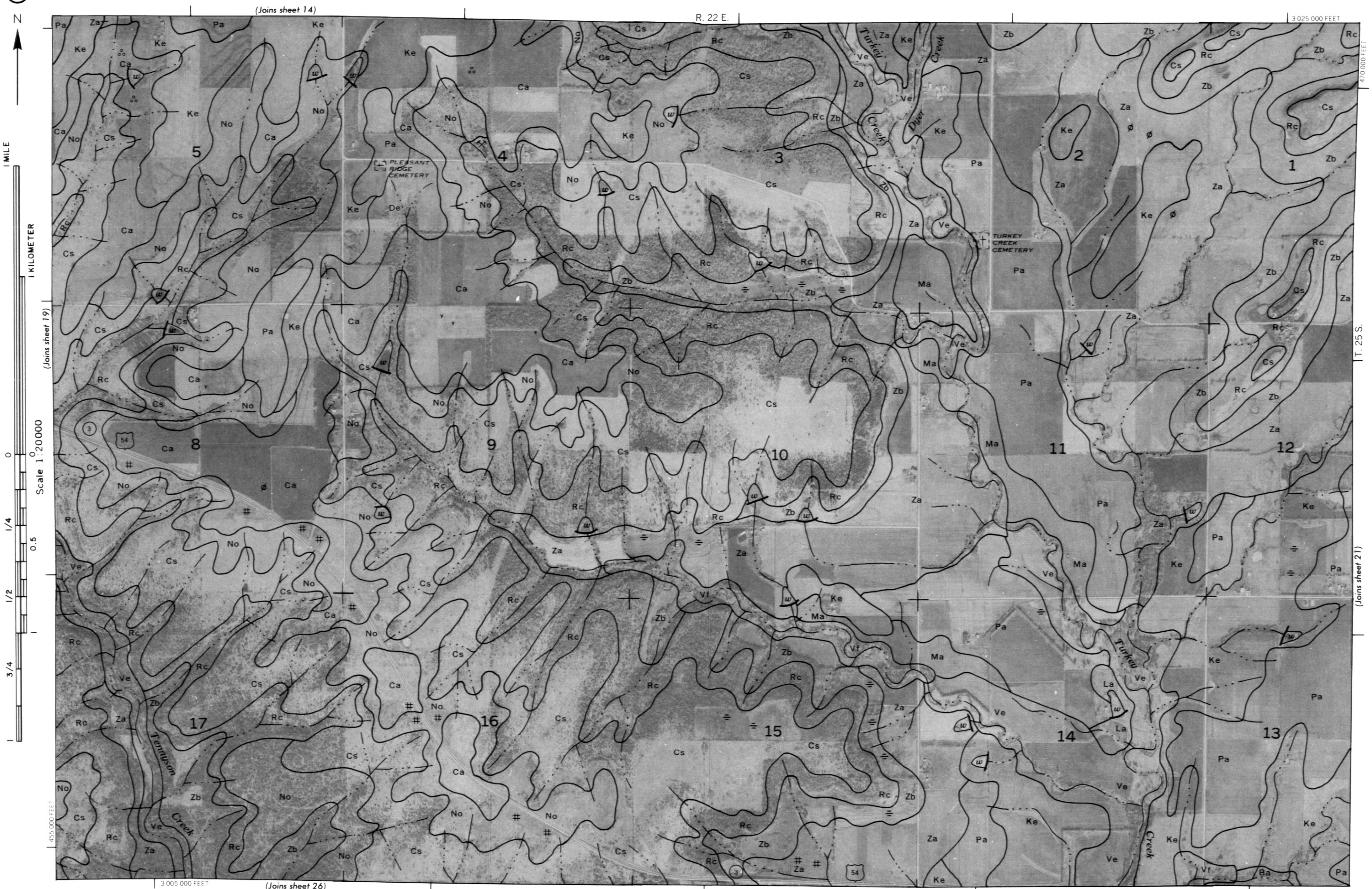

16
N
(Joins sheet 10)
R. 23 E.
R. 24 E.
3 070 000 FEET
(Joins sheet 15)
(Joins sheet 16)
(Joins sheet 22)
T. 24 S.
485 000 FEET
475 000 FEET
3 050 000 FEET
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5
1
Mill Creek
Little Mill Creek
Devon
water
23
24
19
20
21
26
25
30
29
28
35
36
31
32
33

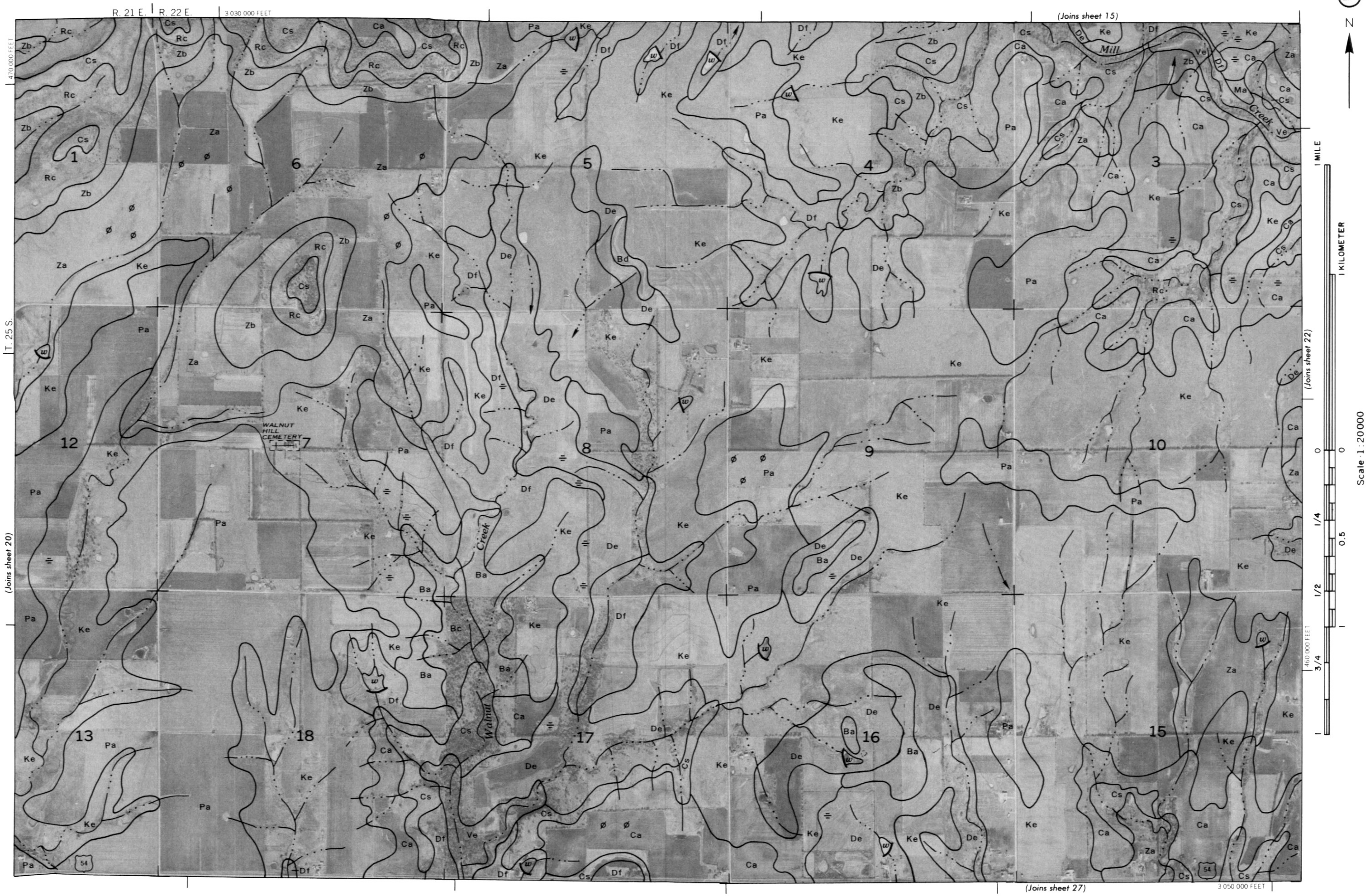
17


3 075 000 FEET
R. 24 E.
R. 25 E.
(Joins sheet 11)
N
485 000 FEET
T. 24 S.
(Joins sheet 16)
(Joins sheet 18)
(Joins sheet 23)
3 095 000 FEET
475 000 FEET
Hammond
SAN FRANCISCO
ST. LOUIS
Wolverine
Creek
water
1 MILE
1 KILOMETER
Scale 1:20 000
0
1/4
1/2
3/4
0.5

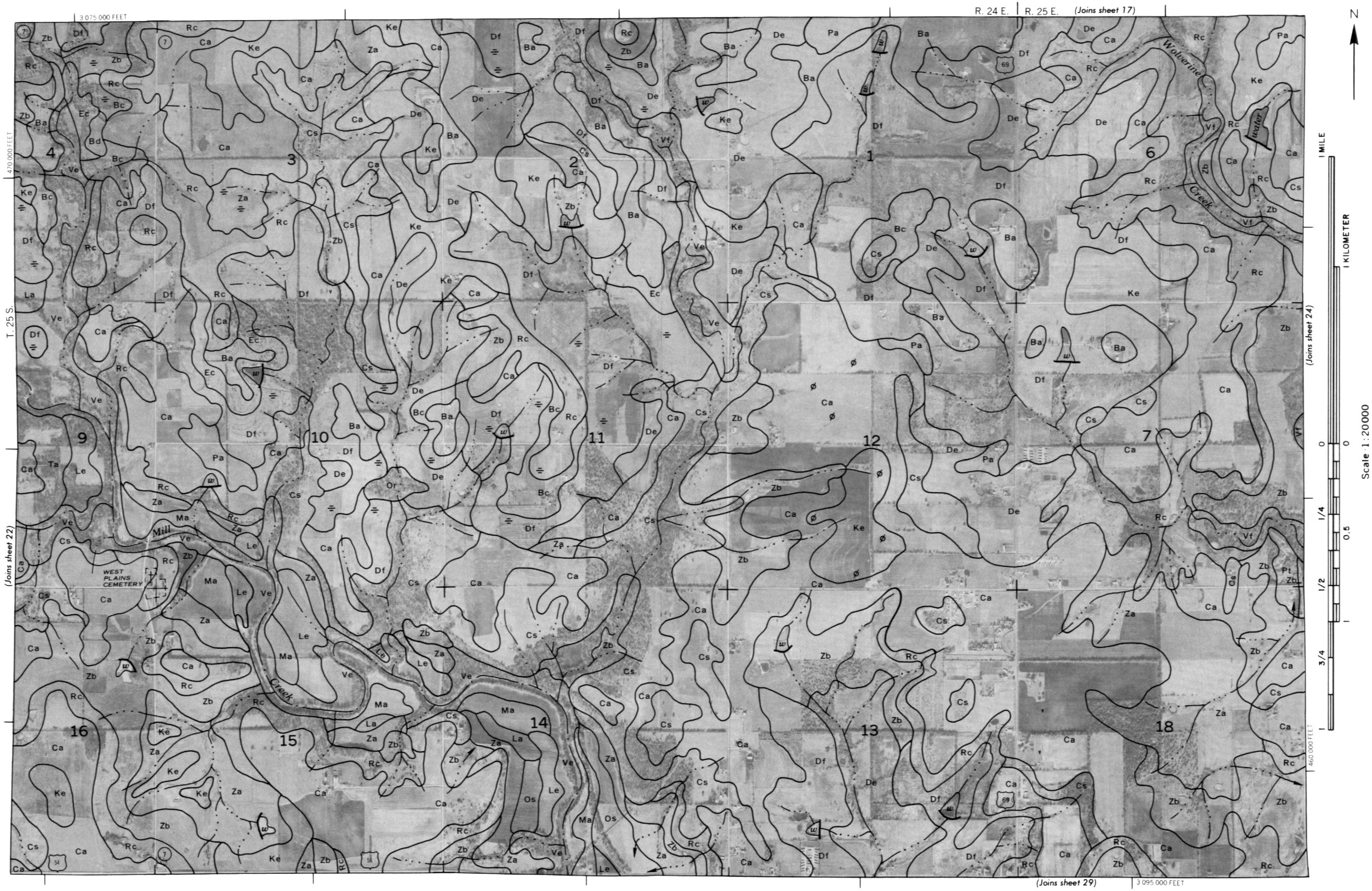

18
N
(Joins sheet 12)
R. 25 E.
3 120 000 FEET
490 000 FEET
(Joins sheet 17)
T. 24 S.
MISSOURI
VERNON COUNTY,
475 000 FEET
3 100 000 FEET
(Joins sheet 24)
1 MILE
1 KILOMETER
Scale 1:20000
Hammond
Hammond Church
ST. LOUIS
SAN FRANCISCO
water
Shiloh
Creek
MAPLE GROVE CEMETERY
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36


2 980 000 FEET
R. 21 E. | R. 22 E.
(Joins sheet 13)
(Joins sheet 20)
(Joins sheet 25)
3 000 000 FEET
465 000 FEET
455 000 FEET
ALLEN COUNTY
T. 25 S.
Bronson
Bronson Reservoir
water
Schubert Creek
Tennyson Creek
1 MILE
1 KILOMETER
Scale 1:20000
N

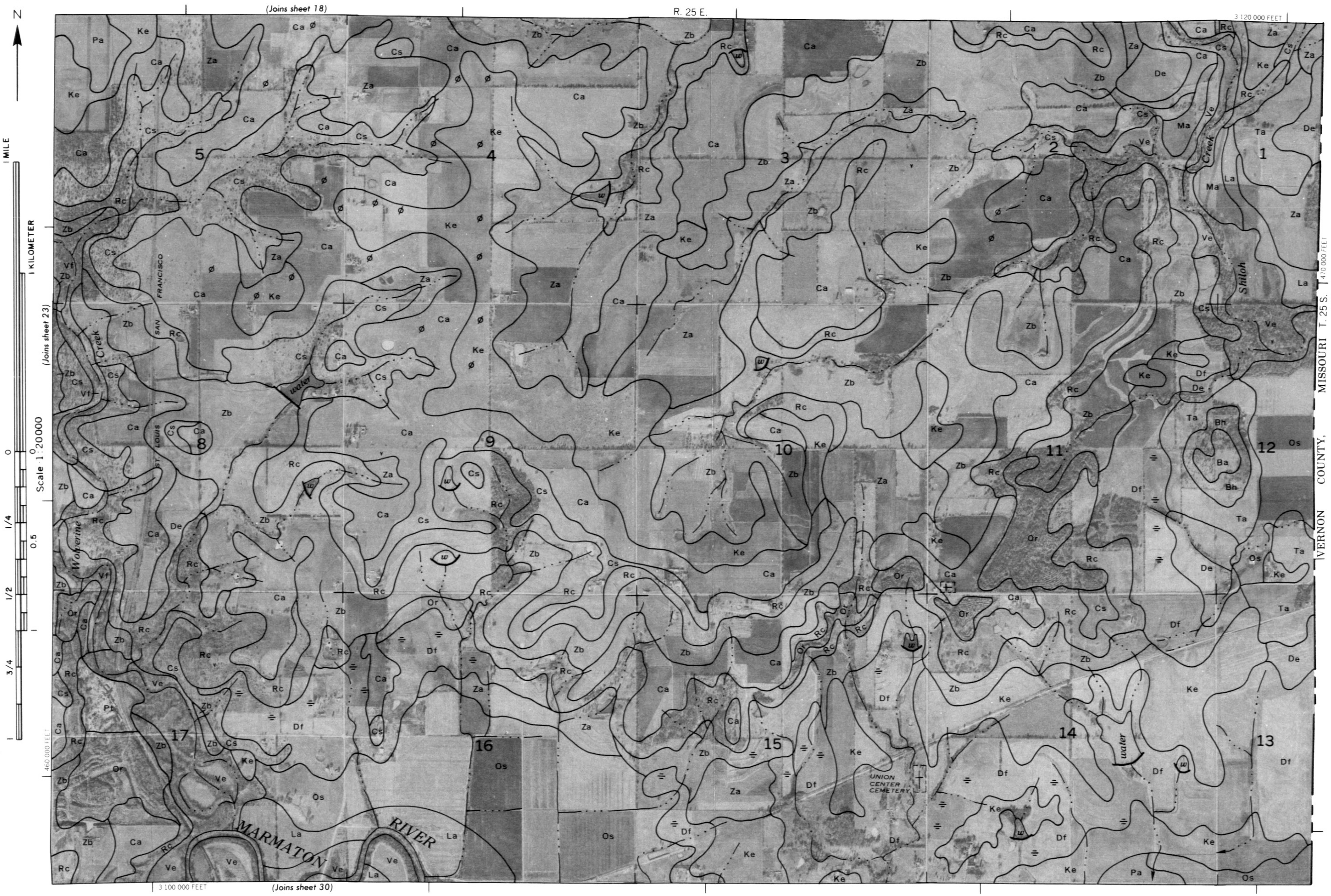

N
1 MILE
1 KILOMETER
Scale 1:20000
(Joins sheet 14)
R. 22 E.
3 025 000 FEET
470 000 FEET
(Joins sheet 19)
T. 25 S.
(Joins sheet 21)
455 000 FEET
3 005 000 FEET
(Joins sheet 26)
PLEASANT RIDGE CEMETERY
TURKEY CREEK CEMETERY
Turkey Creek
Dyer Creek
Tennyson Creek
1
2
3
4
5
8
9
10
11
12
13
14
15
16
17


21
N
R. 21 E.
R. 22 E.
3 030 000 FEET
(Joins sheet 15)
470 000 FEET
T. 25 S.
(Joins sheet 20)
(Joins sheet 22)
(Joins sheet 27)
460 000 FEET
3 050 000 FEET
WALNUT HILL CEMETERY
Mill Creek
Walnut Creek
Creek
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5
1

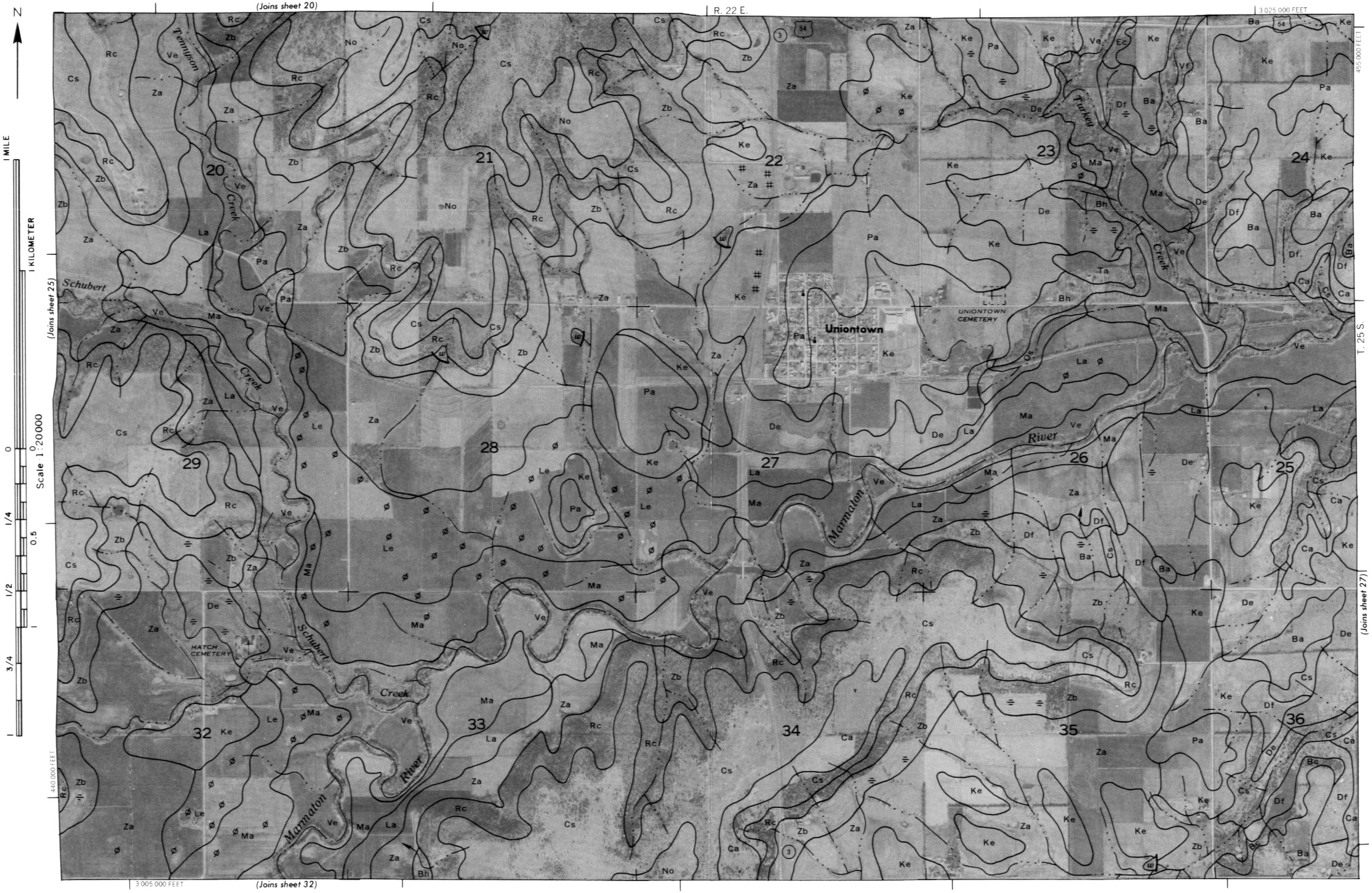

22
N
R. 23 E.
R. 24 E.
(Joins sheet 16)
(Joins sheet 21)
(Joins sheet 23)
(Joins sheet 28)
3 070 000 FEET
470 000 FEET
460 000 FEET
3 055 000 FEET
T. 25 S.
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1
Mill Creek
Mill Creek
CENTERVILLE CEMETERY
water
water
54
54
1
2
4
5
6
7
8
9
11
12
13
14
16
17
18

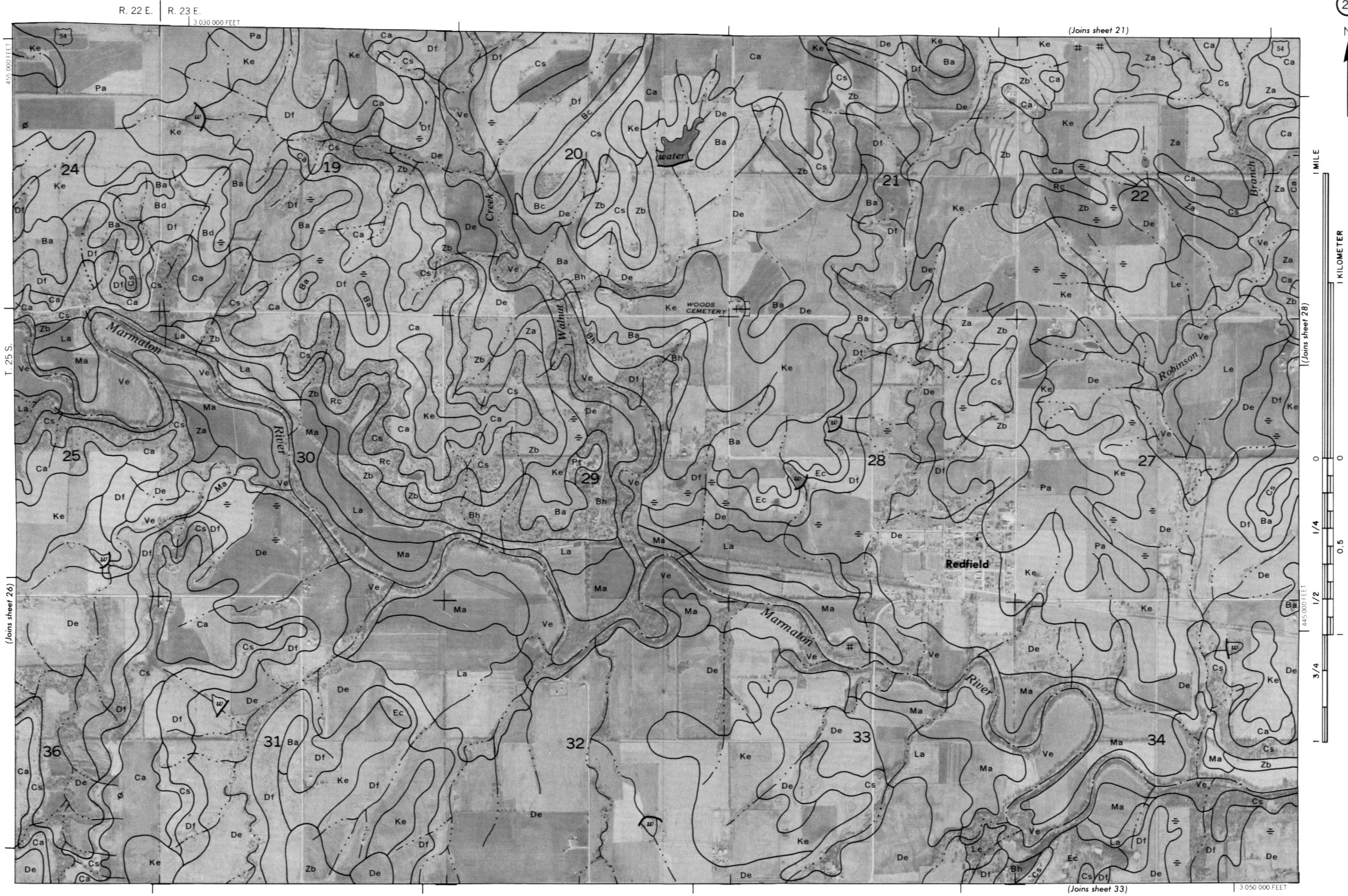

23
N
R. 24 E.
R. 25 E.
(Joins sheet 17)
(Joins sheet 22)
(Joins sheet 24)
(Joins sheet 29)
3 075 000 FEET
3 095 000 FEET
470 000 FEET
460 000 FEET
T. 25 S.
WEST PLAINS CEMETERY
Mill
Creek
Wolverine
Creek
water
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1

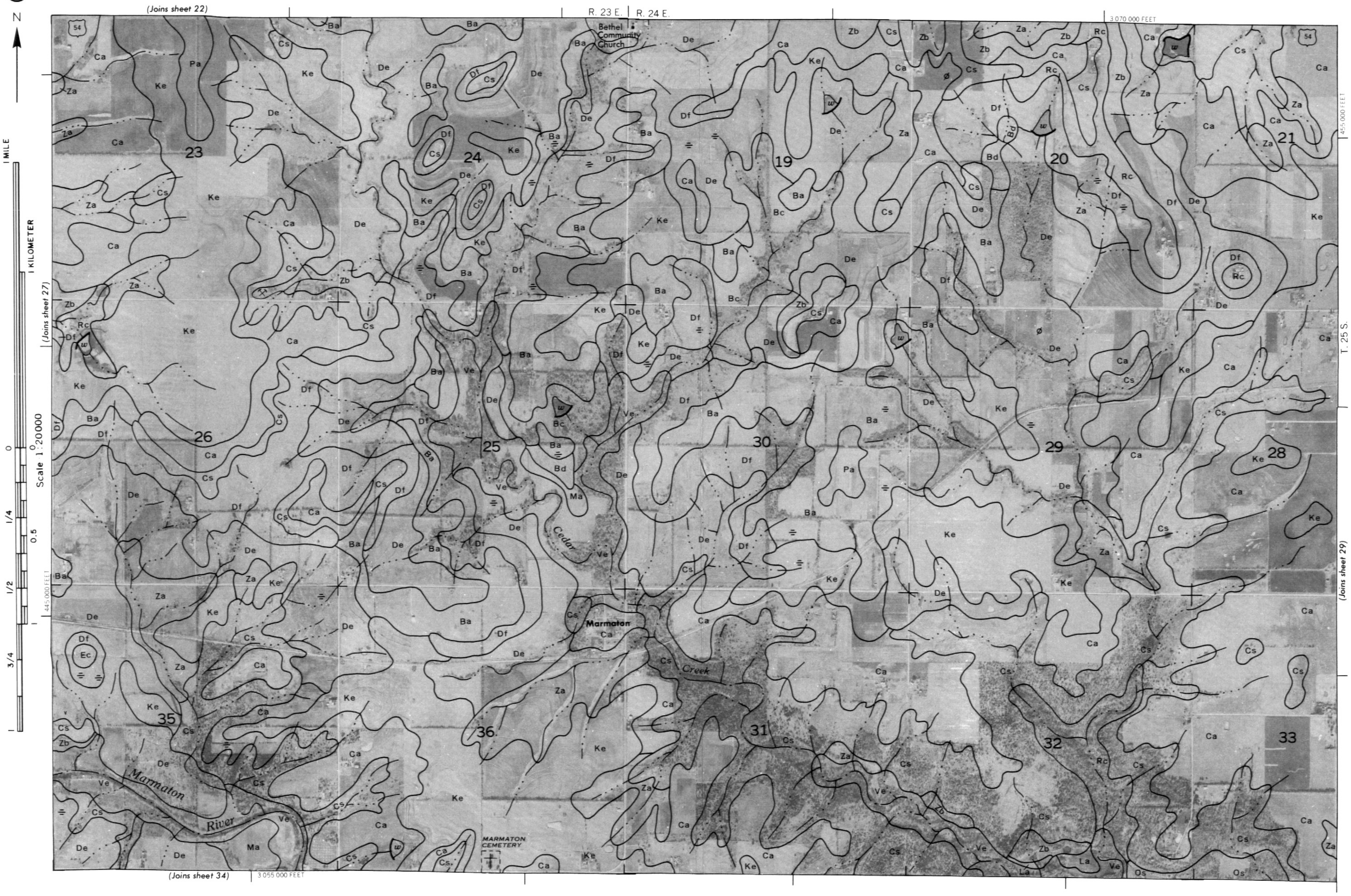
BOURBON COUNTY, KANSAS — SHEET NUMBER 24



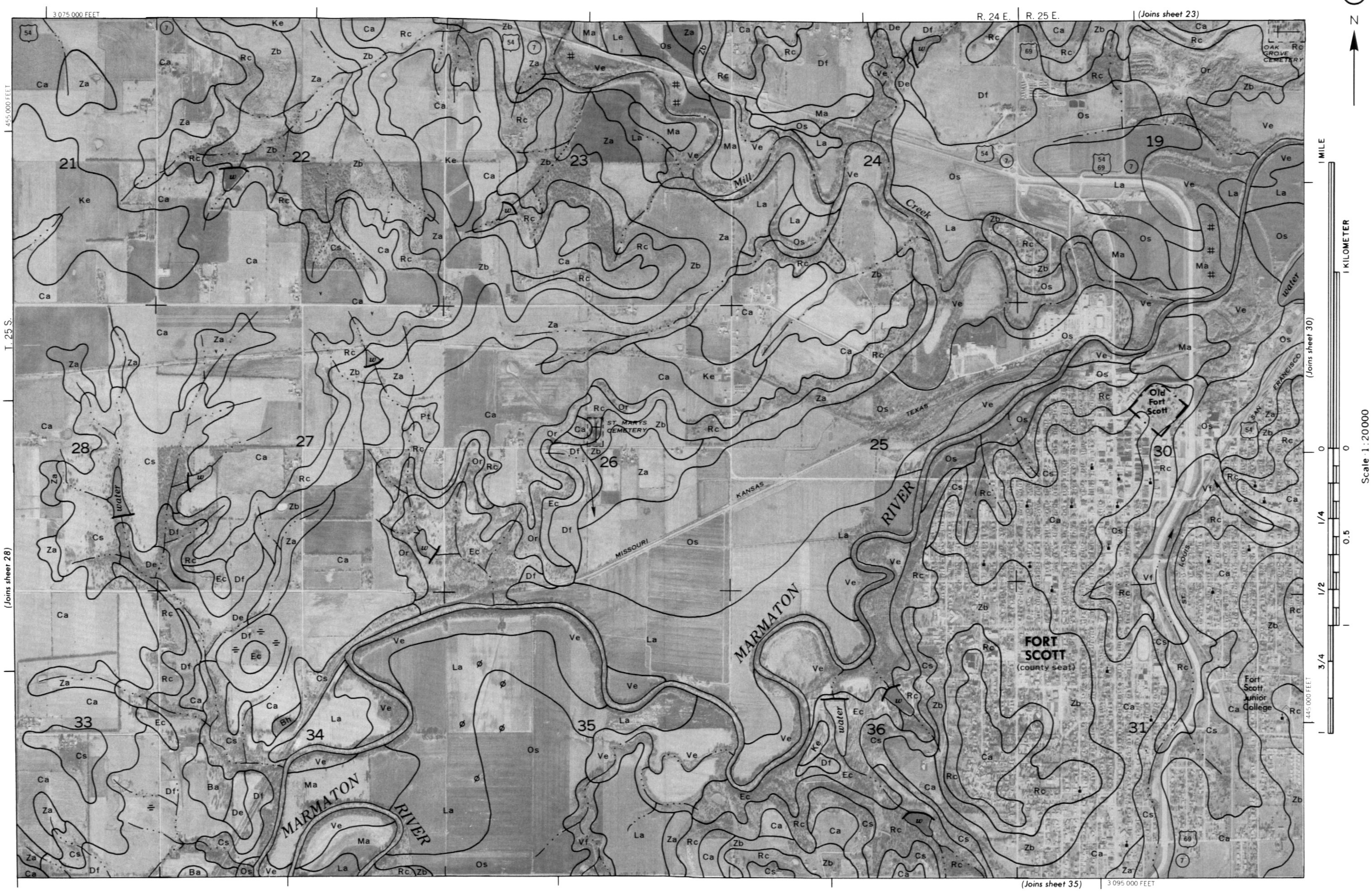

N
2 980 000 FEET
R. 21 E.
R. 22 E.
(Joins sheet 19)
(Joins sheet 26)
(Joins sheet 31)
3 000 000 FEET
450 000 FEET
440 000 FEET
T. 25 S.
ALLEN COUNTY
Schubert
Creek
23
24
19
26
25
30
35
36
31
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
1
0
0.5
1
Scale 1:20000


(Joins sheet 20)
(Joins sheet 25)
(Joins sheet 27)
(Joins sheet 32)
R. 22 E.
T. 25 S.
3 025 000 FEET
455 000 FEET
440 000 FEET
3 005 000 FEET
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5
Uniontown
UNIONTOWN CEMETERY
HATCH CEMETERY
Tennyson Creek
Schubert Creek
Turkey Creek
Marmaton River
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36

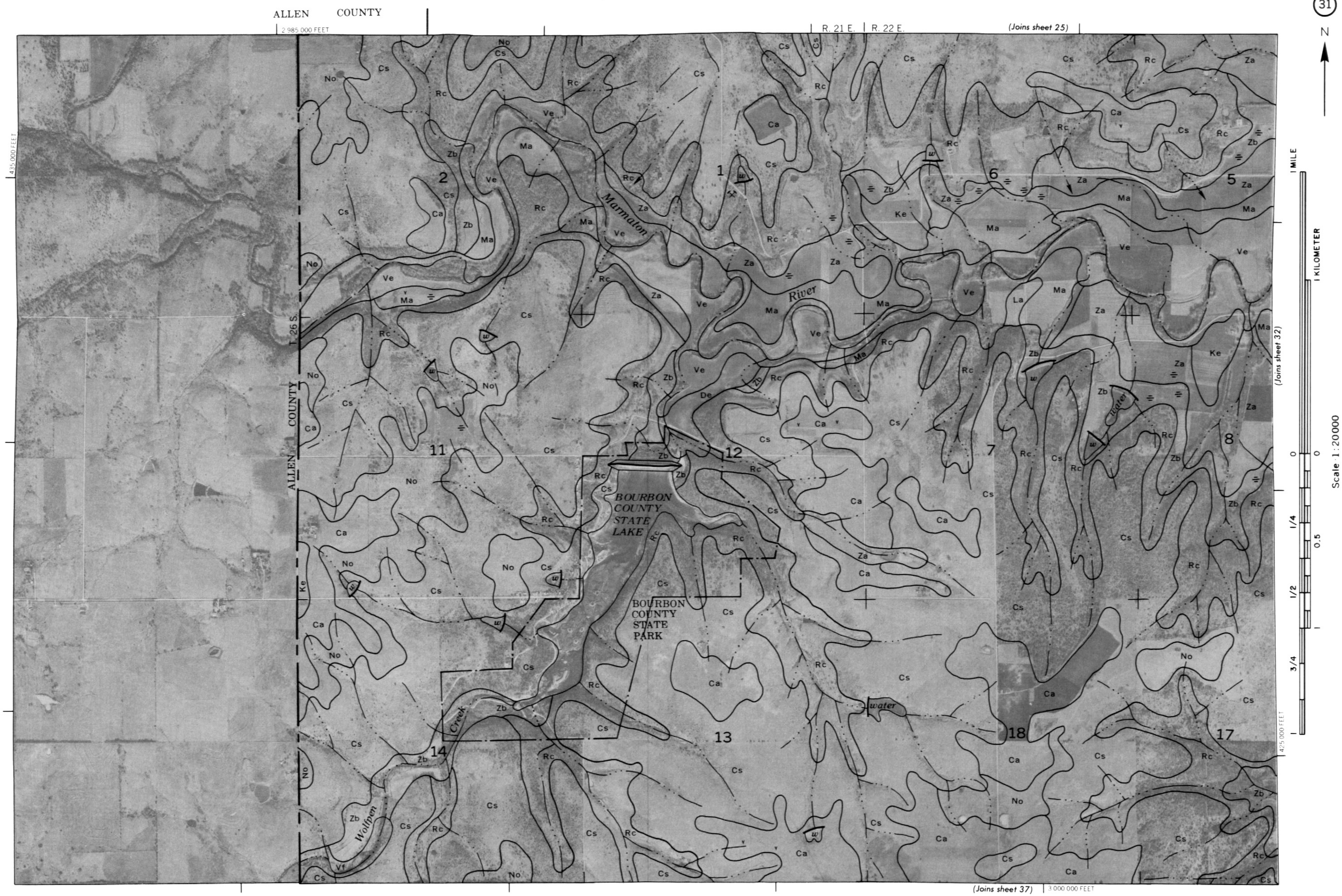

27
R. 22 E.
R. 23 E.
3 030 000 FEET
455 000 FEET
(Joins sheet 21)
(Joins sheet 28)
(Joins sheet 26)
(Joins sheet 33)
3 050 000 FEET
445 000 FEET
T. 25 S.
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5
54
Marmaton River
Walnut Creek
Robinson Branch
WOODS CEMETERY
Redfield
water
19
20
21
22
24
25
27
28
29
30
31
32
33
34
36


N
(Joins sheet 22)
R. 23 E.
R. 24 E.
Bethel Community Church
3 070 000 FEET
455 000 FEET
T. 25 S.
(Joins sheet 27)
(Joins sheet 29)
(Joins sheet 34)
3 055 000 FEET
445 000 FEET
Marmaton
Cedar
Creek
Marmaton
River
MARMATON CEMETERY
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0
0.5
1

BOURBON COUNTY, KANSAS — SHEET NUMBER 29

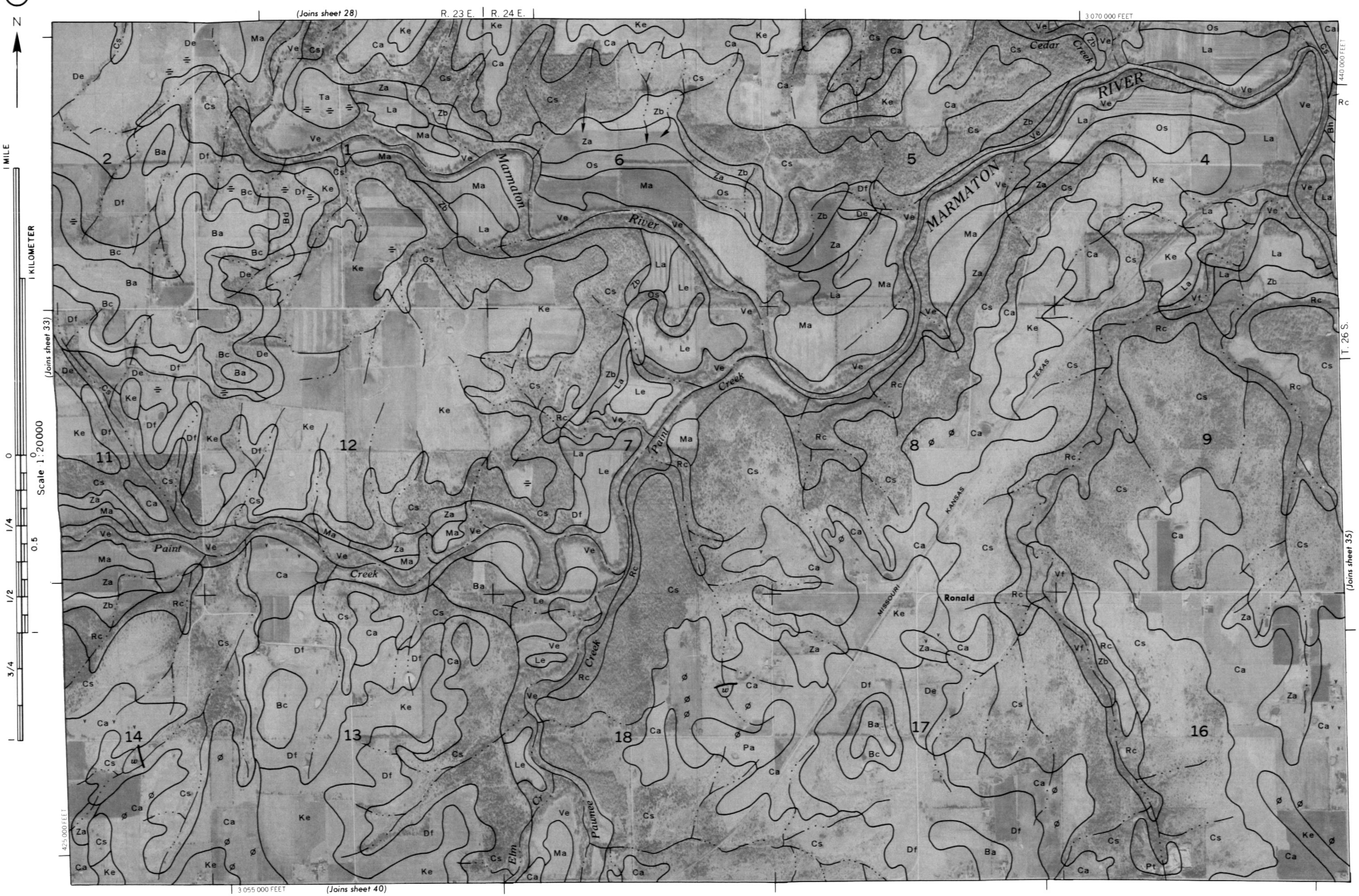



(Joins sheet 24)
R. 25 E.
3 120 000 FEET
MARMATON RIVER
ST. LOUIS SAN FRANCISCO
MISSOURI KANSAS TEXAS
MKT
SLSF
LATH BRANCH CEMETERY
FORT SCOTT (county seat)
NATIONAL CEMETERY
T. 25 S.
455 000 FEET
445 000 FEET
(Joins sheet 29)
MISSOURI
VERNON COUNTY,
3 100 000 FEET
(Joins sheet 36)
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36
water
N

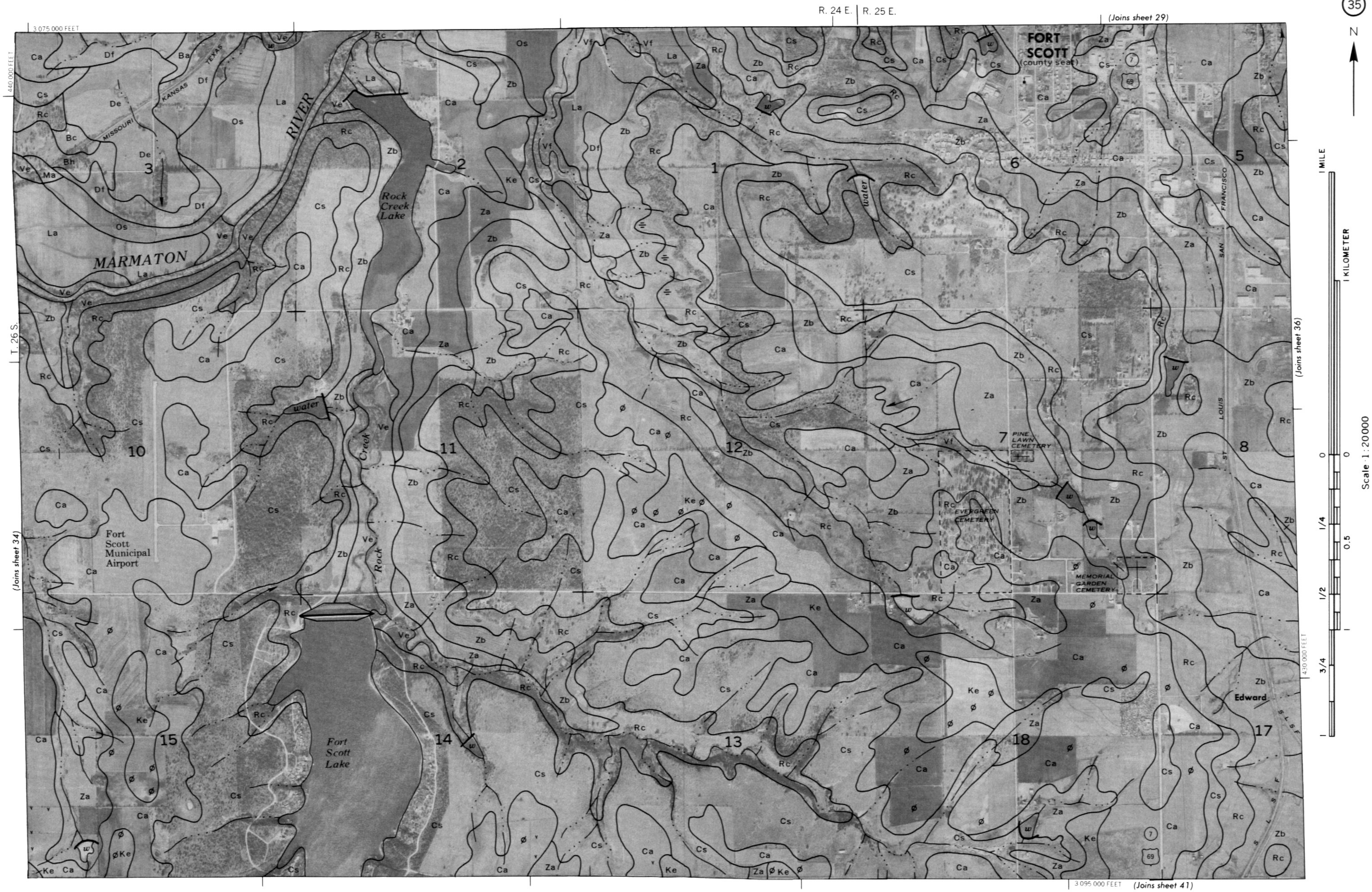

ALLEN COUNTY
2 985 000 FEET
R. 21 E.
R. 22 E.
(Joins sheet 25)
31
N
435 000 FEET
T. 26 S.
ALLEN COUNTY
Marmaton
River
BOURBON COUNTY STATE LAKE
BOURBON COUNTY STATE PARK
Wolfpen
Creek
water
(Joins sheet 32)
1 MILE
1 KILOMETER
0
1/4
0.5
1/2
3/4
Scale 1:20000
425 000 FEET
(Joins sheet 37)
3 000 000 FEET


32
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0
0.5
(Joins sheet 26)
(Joins sheet 31)
(Joins sheet 33)
(Joins sheet 38)
R. 22 E.
T. 26 S.
3 025 000 FEET
435 000 FEET
425 000 FEET
3 005 000 FEET
Marmaton River
Paint Creek
Petersburg
1
2
3
4
5
8
9
10
11
12
13
14
15
16
17


3 030 000 FEET
R. 23 E.
(Joins sheet 27)
T. 26 S.
435 000 FEET
(Joins sheet 32)
(Joins sheet 34)
(Joins sheet 39)
3 050 000 FEET
425 000 FEET
MT. ZION CEMETERY
MT. ORUM CEMETERY
Mt. Orum Church
MARION CEMETERY
Paint Creek Church
Paint Creek
Bunion Creek
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5

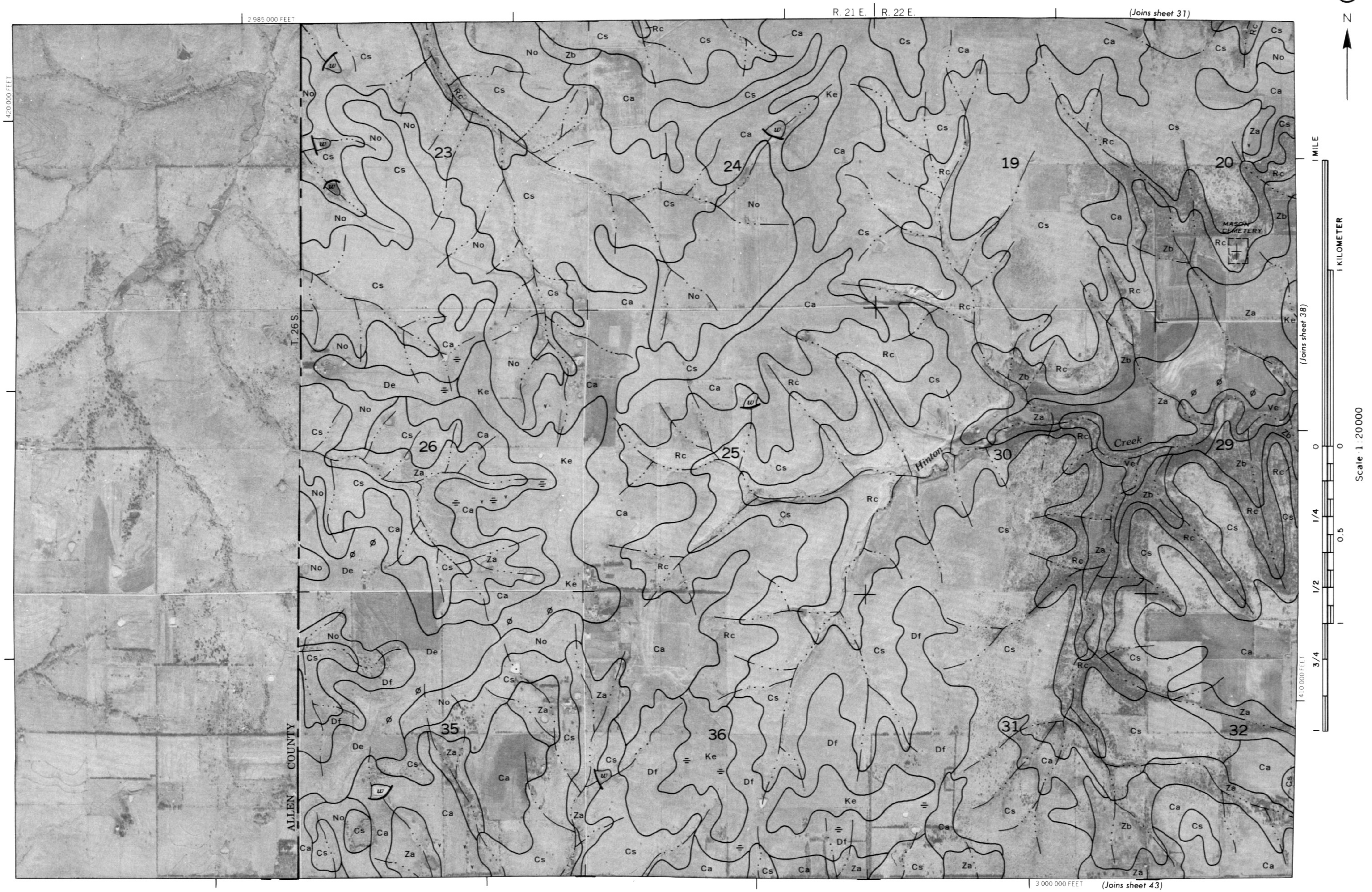

N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5
(Joins sheet 28)
R. 23 E.
R. 24 E.
3 070 000 FEET
440 000 FEET
T. 26 S.
(Joins sheet 33)
(Joins sheet 35)
(Joins sheet 40)
3 055 000 FEET
425 000 FEET
Marmaton River
MARMATON RIVER
Cedar Creek
Paint Creek
Paint Creek
Elm Cr
Pawnee Creek
Ronald
MISSOURI
KANSAS
TEXAS
1
2
4
5
6
7
8
9
11
12
13
14
16
17
18

BOURBON COUNTY, KANSAS — SHEET NUMBER 35

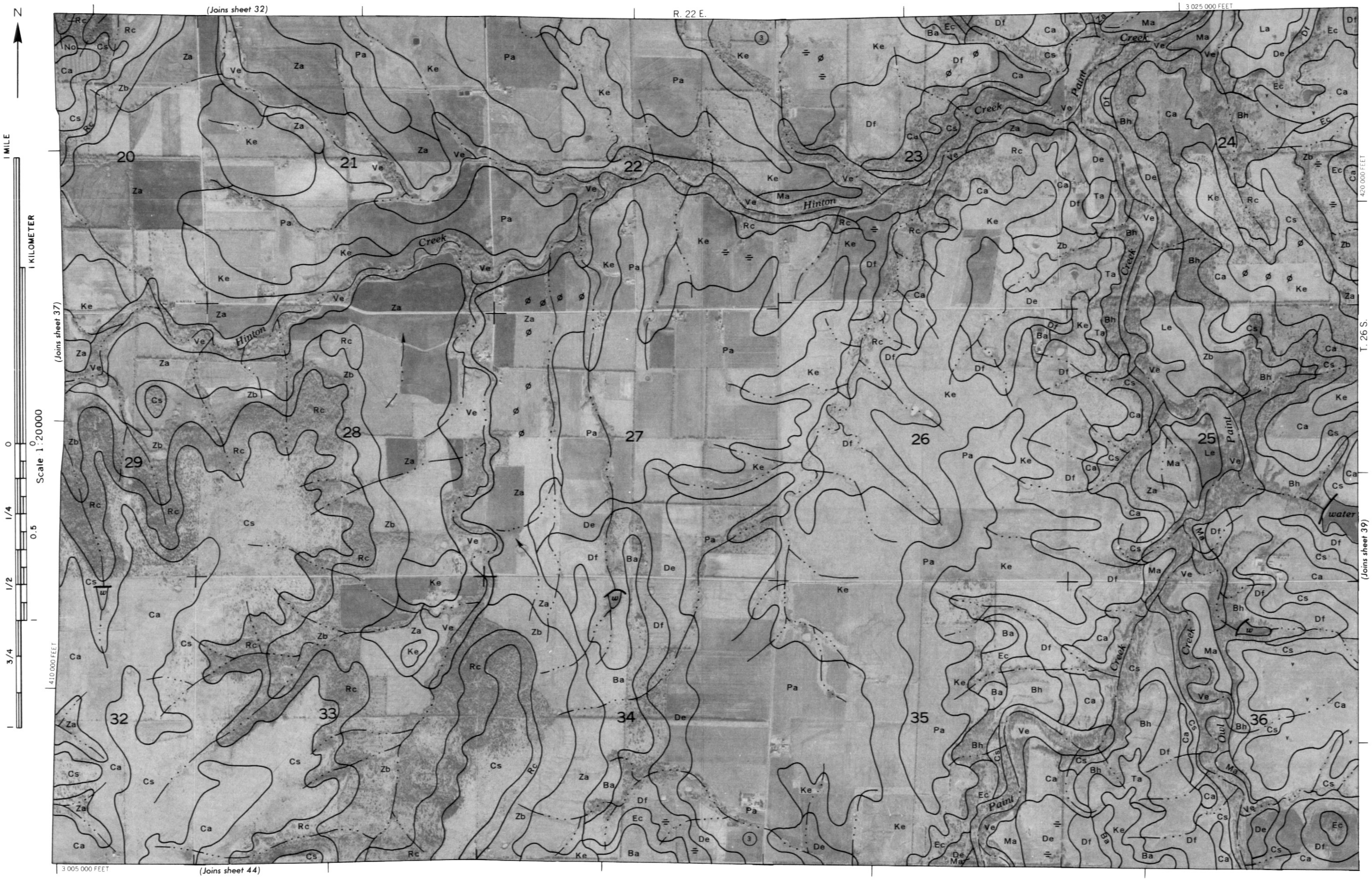


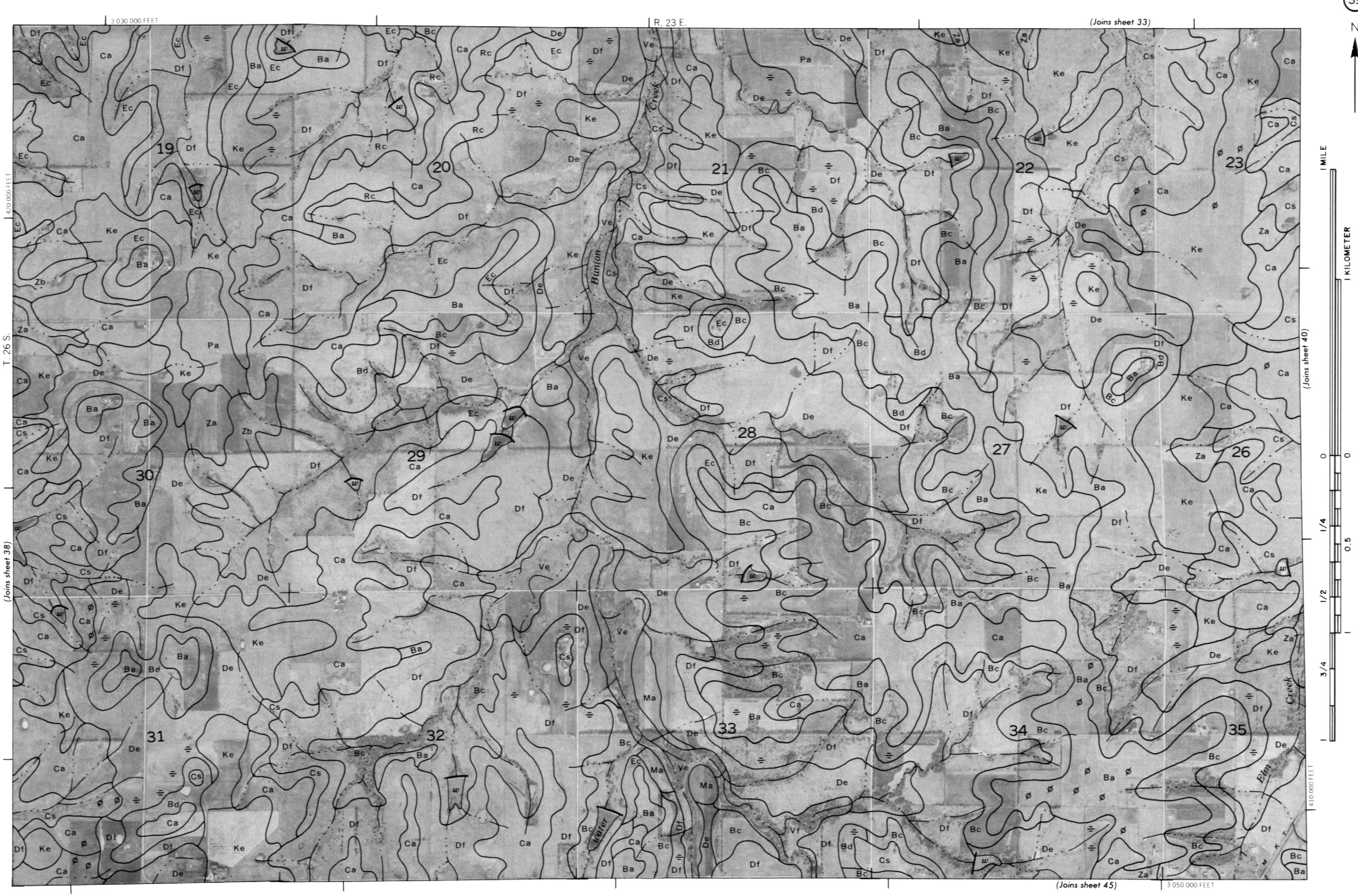
36

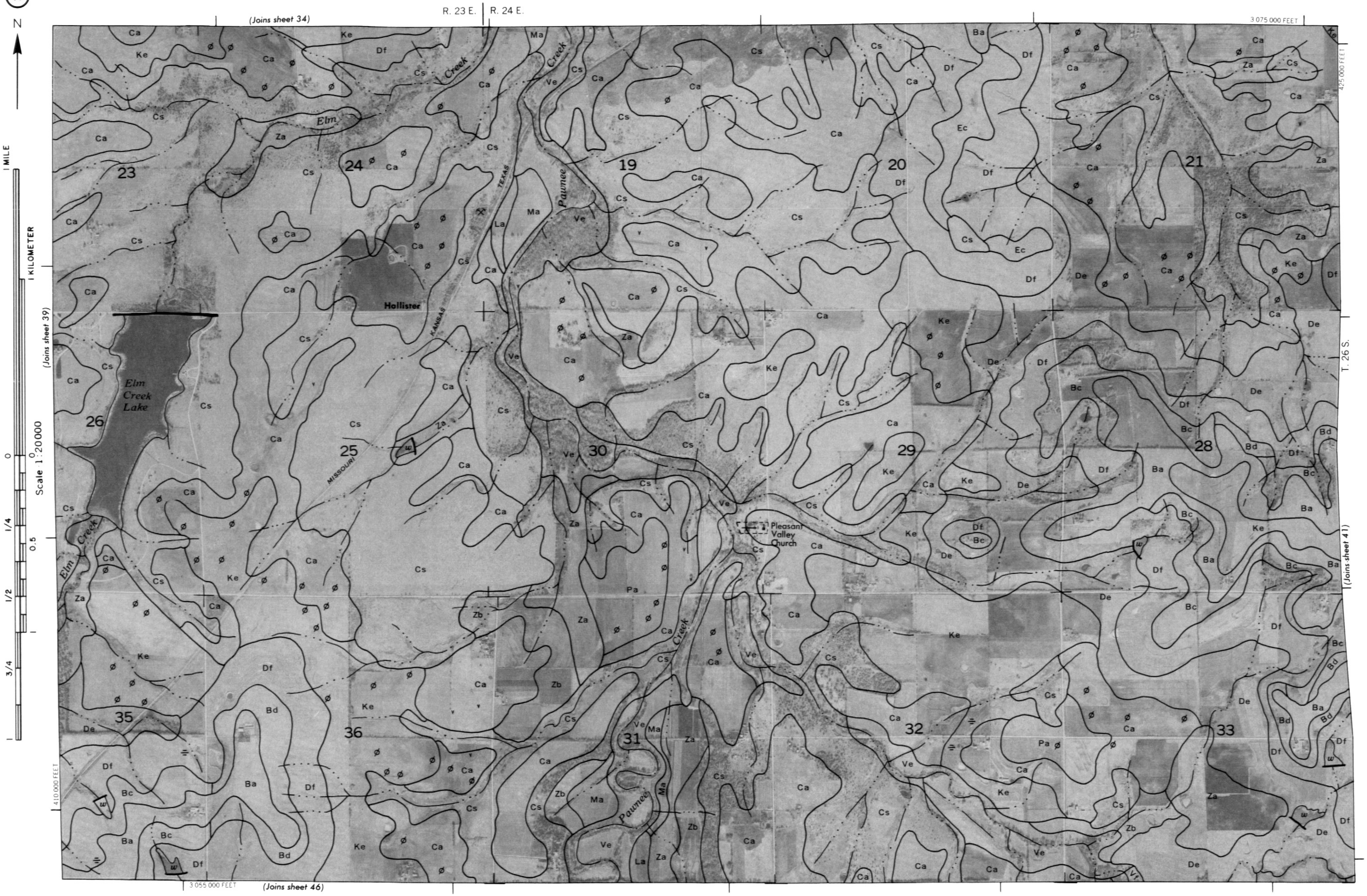
BOURBON COUNTY, KANSAS — SHEET NUMBER 36



2 985 000 FEET
R. 21 E.
R. 22 E.
(Joins sheet 31)
N
420 000 FEET
T. 26 S.
ALLEN COUNTY
(Joins sheet 38)
MASON CEMETERY
Hinton Creek
410 000 FEET
3 000 000 FEET
(Joins sheet 43)
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
1
0
0.5
1
Scale 1:20000
19
20
23
24
25
26
29
30
31
32
35
36


N
(Joins sheet 32)
R. 22 E.
3 025 000 FEET
420 000 FEET
T. 26 S.
(Joins sheet 37)
(Joins sheet 39)
(Joins sheet 44)
410 000 FEET
3 005 000 FEET
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1
Hinton Creek
Paint Creek
Owl Creek
water
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36

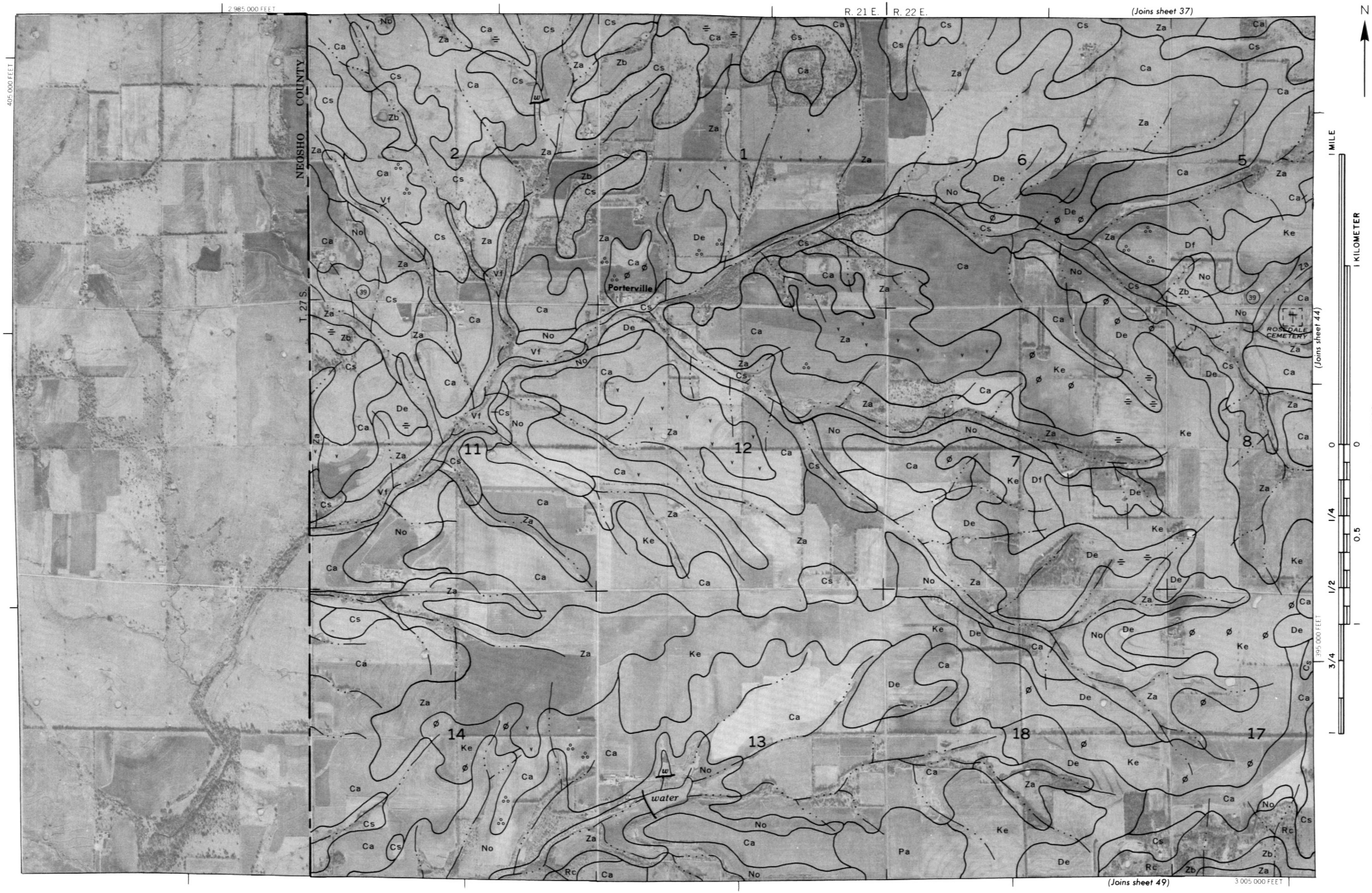

3 030 000 FEET
R. 23 E.
(Joins sheet 33)
N
420 000 FEET
T. 26 S.
(Joins sheet 38)
(Joins sheet 40)
(Joins sheet 45)
3 050 000 FEET
410 000 FEET
Bunion Creek
Elm Creek
Water
19
20
21
22
23
26
27
28
29
30
31
32
33
34
35
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
0.5
Scale 1 : 20000


N
R. 23 E.
R. 24 E.
(Joins sheet 34)
(Joins sheet 39)
(Joins sheet 41)
(Joins sheet 46)
T. 26 S.
3 075 000 FEET
425 000 FEET
410 000 FEET
3 055 000 FEET
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1
Elm Creek Lake
Elm
Elm Creek
Creek
Pawnee
Pawnee Creek
Creek
Hollister
KANSAS
TEXAS
MISSOURI
Pleasant Valley Church
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36

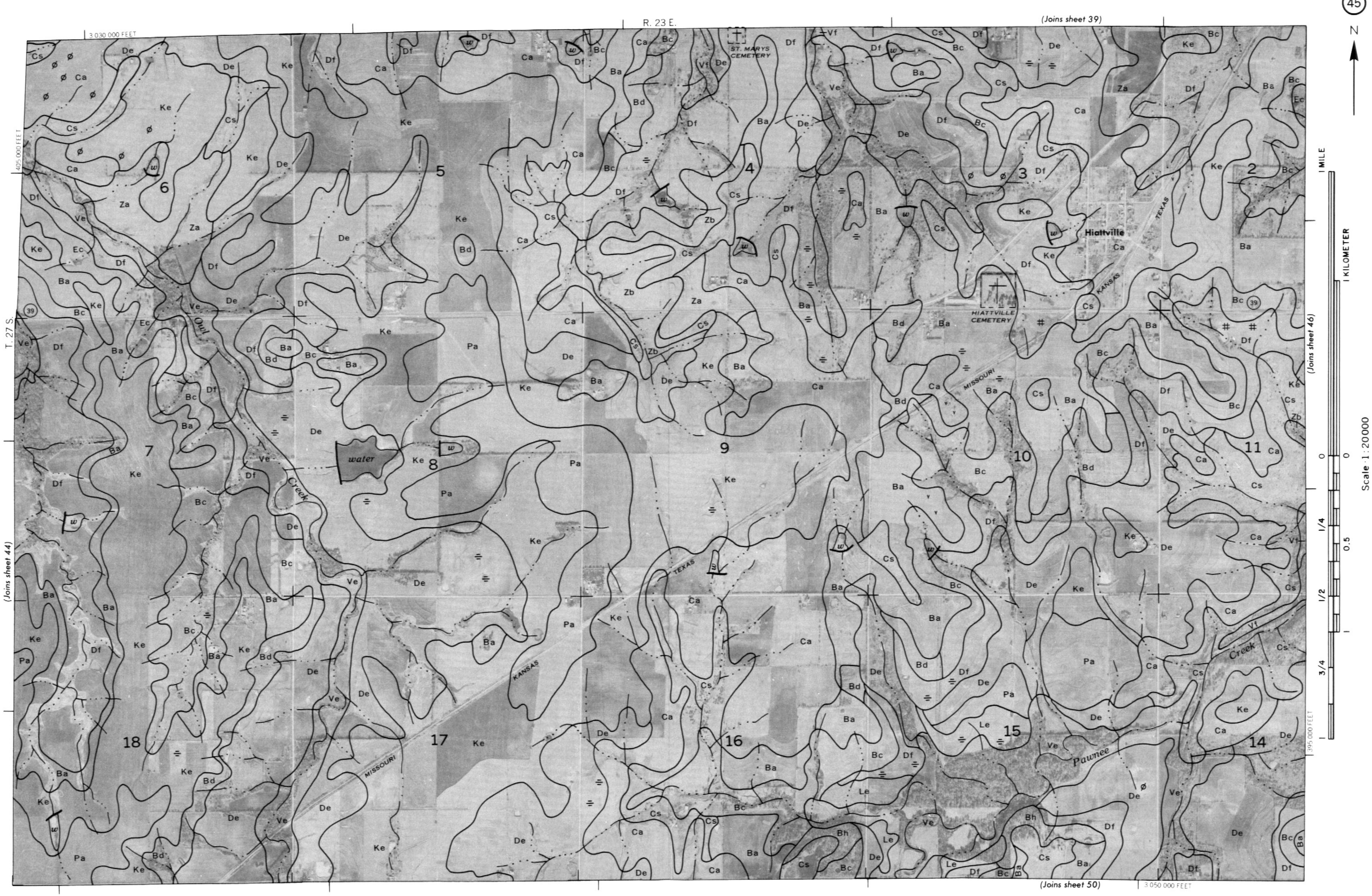

(Joins sheet 35)
(Joins sheet 42)
(Joins sheet 47)
(Joins sheet 40)
3 080 000 FEET
3 100 000 FEET
425 000 FEET
415 000 FEET
R. 24 E. | R. 25 E.
T. 26 S.
N
Fort Scott Lake
water
Rock Creek
Moores Branch
Godfrey
SAN FRANCISCO
ST. LOUIS
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5


N
(Joins sheet 36)
R. 25 E.
3 120 000 FEET
425 000 FEET
(Joins sheet 41)
(Joins sheet 48)
3 105 000 FEET
415 000 FEET
T. 26 S.
MISSOURI
VERNON COUNTY,
Clarksburg Valley Chapel
CLARKSBURG CEMETERY
Moores Branch
ST. LOUIS
SAN FRANCISCO
Garland
water
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0.5

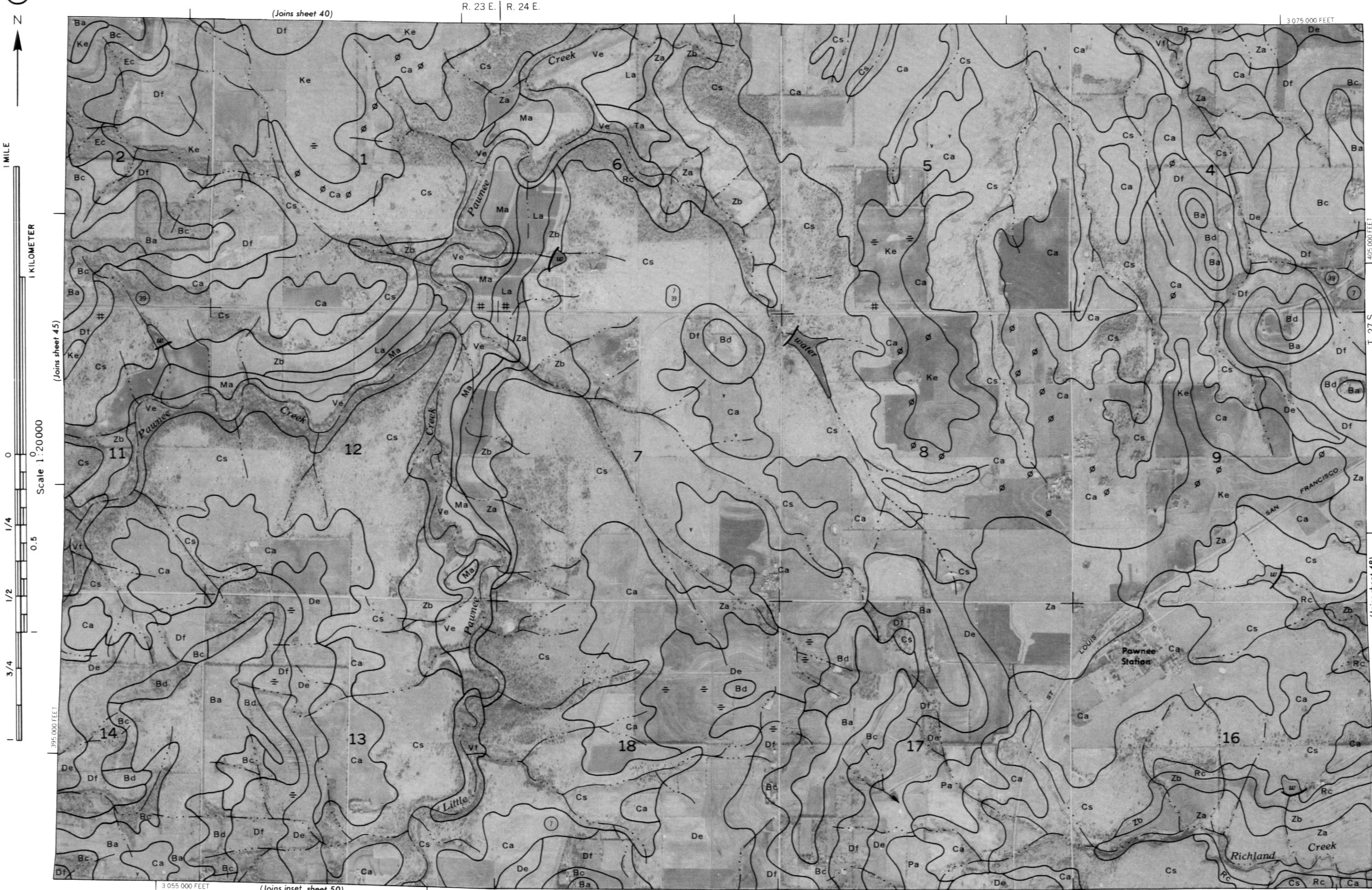
BOURBON COUNTY, KANSAS — SHEET NUMBER 43




N
(Joins sheet 38)
R. 22 E.
3 025 000 FEET
405 000 FEET
T. 27 S.
(Joins sheet 45)
(Joins inset, sheet 49)
3 010 000 FEET
(Joins sheet 43)
395 000 FEET
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5
Owl Cr
Prong
Creek
Paint
Creek
water

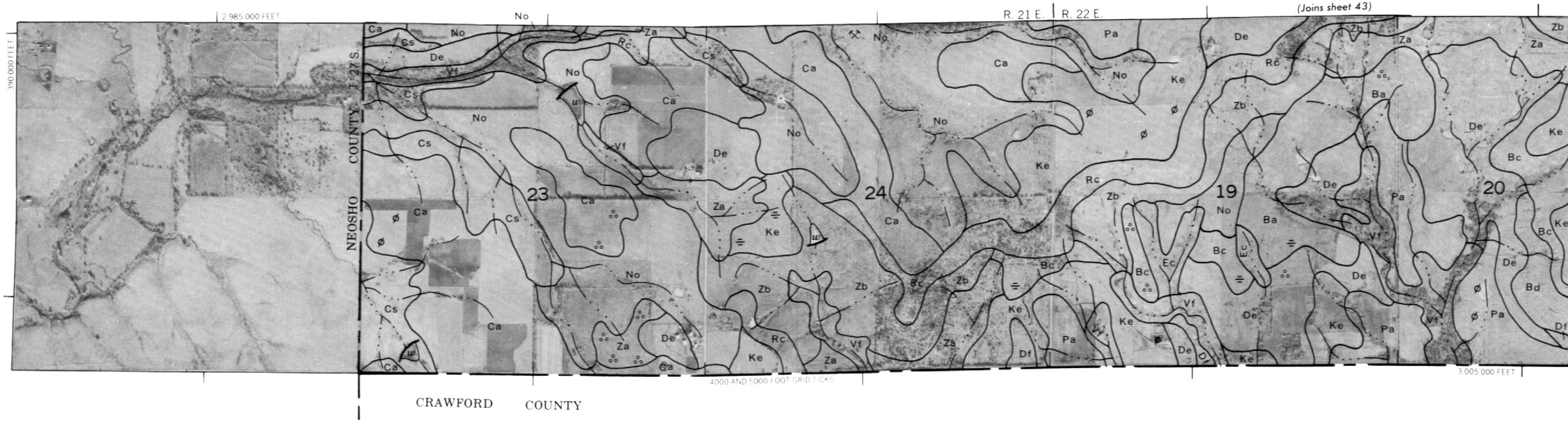

45
N
R. 23 E.
(Joins sheet 39)
(Joins sheet 46)
(Joins sheet 50)
(Joins sheet 44)
T. 27 S.
3 030 000 FEET
3 050 000 FEET
405 000 FEET
395 000 FEET
ST. MARYS CEMETERY
HIATTVILLE CEMETERY
Hiattville
Owl Creek
Pawnee Creek
water
MISSOURI
KANSAS
TEXAS
39
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5

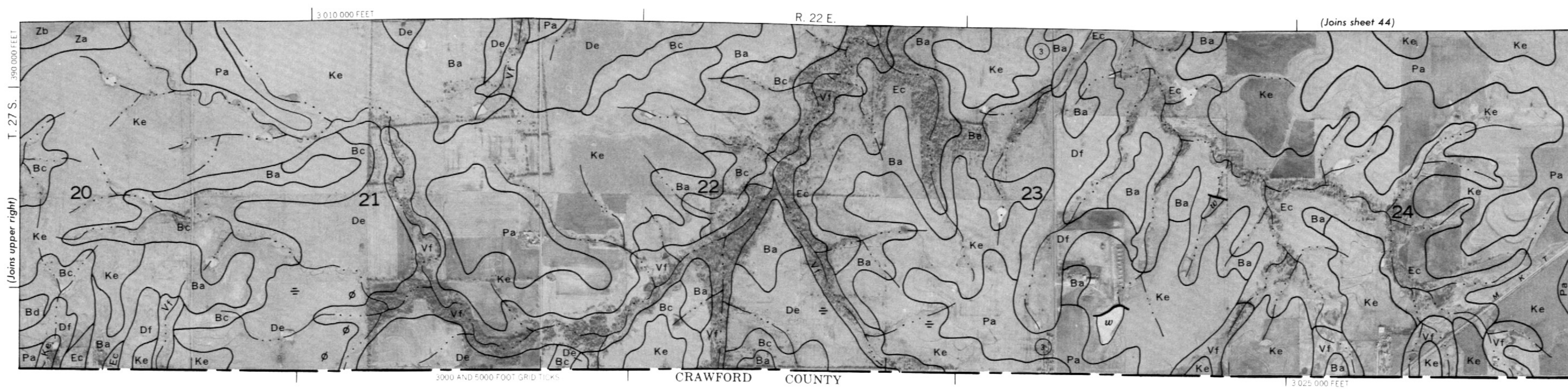
BOURBON COUNTY, KANSAS — SHEET NUMBER 46

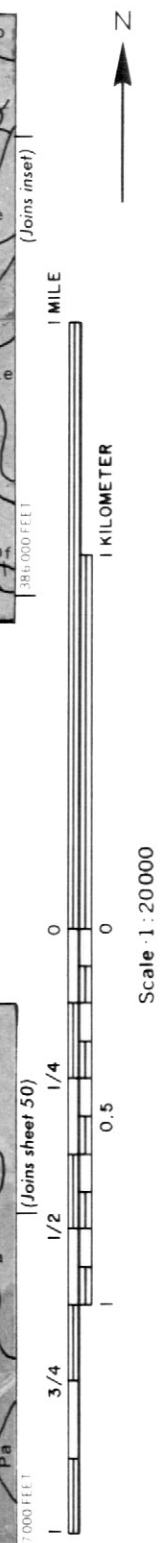


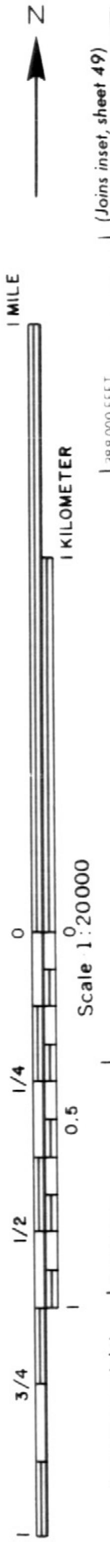

3 080 000 FEET
R. 24 E. | R. 25 E.
(Joins sheet 41)
(Joins sheet 48)
(Joins sheet 46)
(Joins sheet 51)
T. 27 S.
405 000 FEET
395 000 FEET
3 100 000 FEET
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
ST. LOUIS SAN FRANCISCO
water
Walnut
Creek
Richland
Creek
Cherry Grove Church
PLEASANT VIEW CEMETERY
69
1
2
3
5
6
7
8
10
11
12
13
14
15
17
18

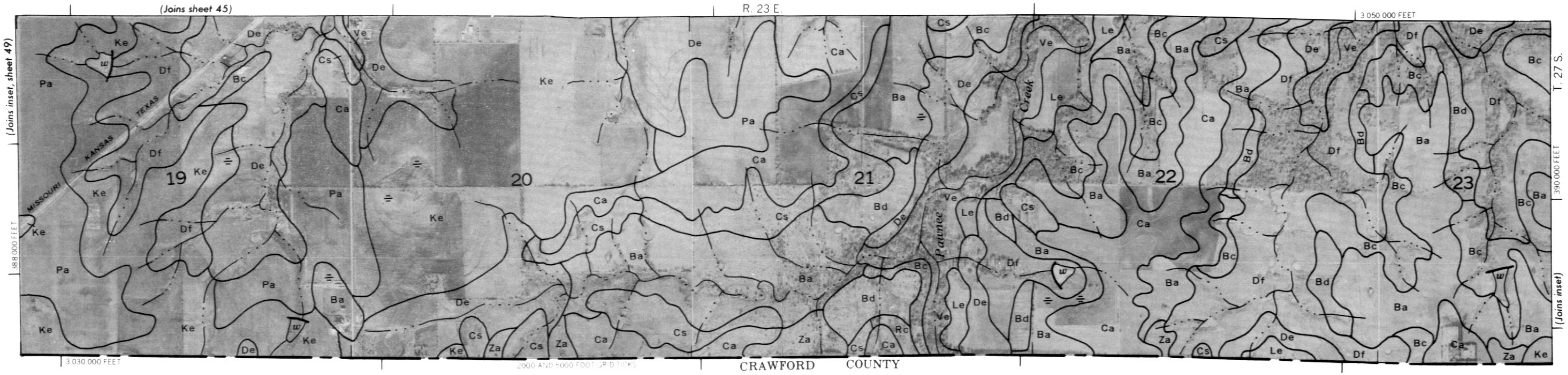

(Joins sheet 42)
R. 25 E.
3 120 000 FEET
Garland
410 000 FEET
T. 27 S.
MISSOURI
VERNON COUNTY,
SAN FRANCISCO
ST. LOUIS
(Joins sheet 47)
TWEEDY CEMETERY
MATFIELD CEMETERY
Buck
Run
Wood
Dry
Fork
West
Creek
395 000 FEET
(Joins inset, sheet 51)
3 105 000 FEET
N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
0.5

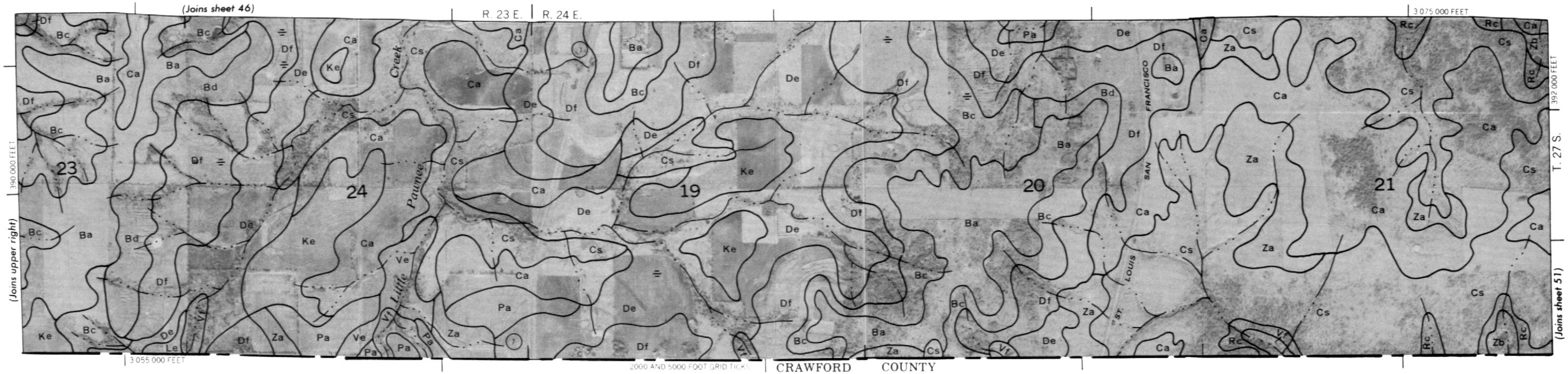

2 985 000 FEET
390 000 FEET
R. 21 E.
R. 22 E.
(Joins sheet 43)
T. 27 S.
NEOSHO COUNTY
23
24
19
20
(Joins inset)
386 000 FEET
3 005 000 FEET
4000 AND 5000 FOOT GRID TICKS
CRAWFORD COUNTY

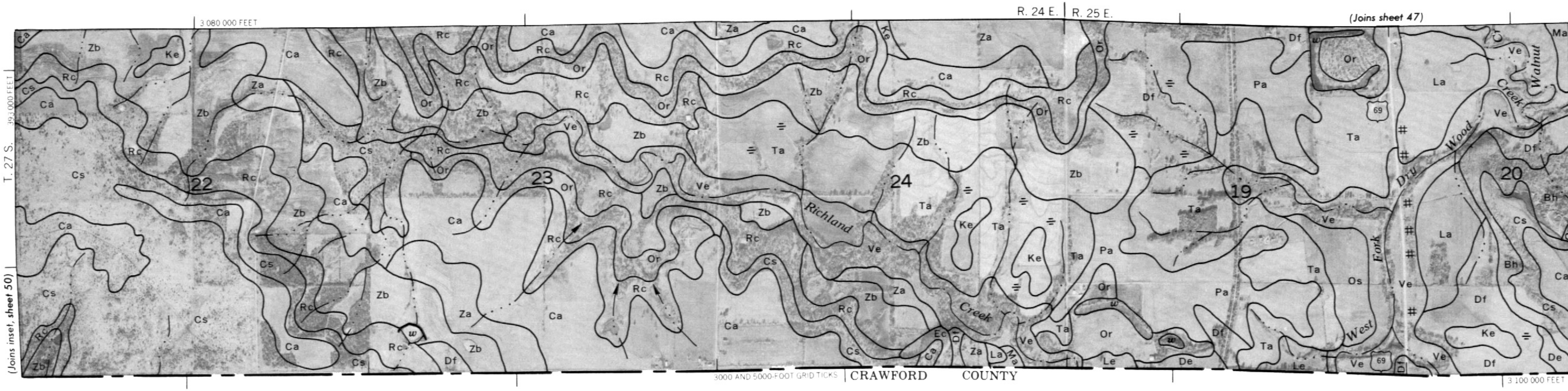

3 010 000 FEET
390 000 FEET
R. 22 E.
(Joins sheet 44)
T. 27 S.
(Joins upper right)
20
21
22
23
24
(Joins sheet 50)
387 000 FEET
3 025 000 FEET
3000 AND 5000 FOOT GRID TICKS
CRAWFORD COUNTY

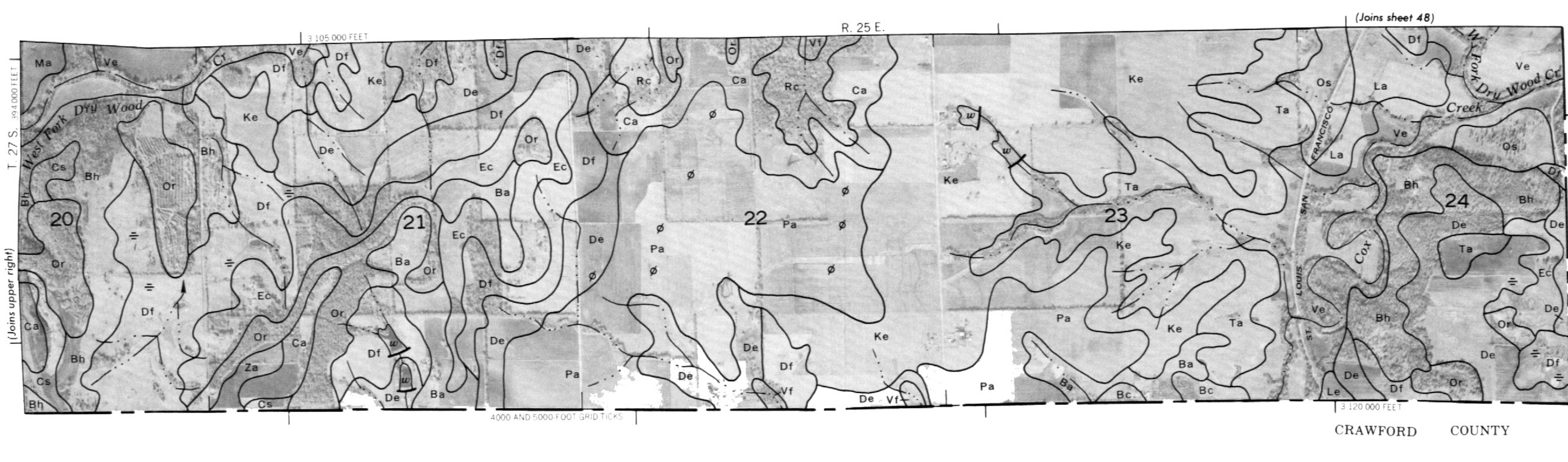

N
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
1
0
0.5
1
Scale 1 : 20000

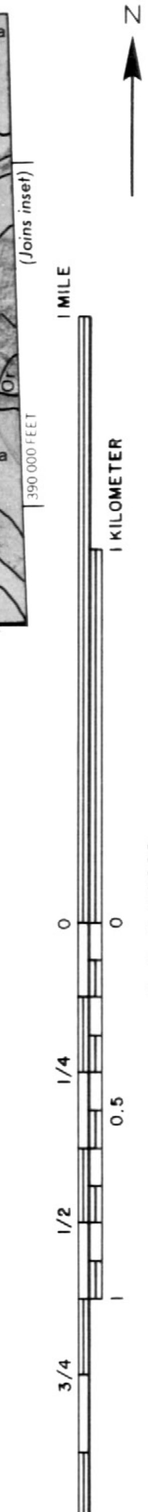

N
1 MILE
1 KILOMETER
Scale 1:20000
0
1/4
1/2
3/4
1
0
0.5
1


(Joins sheet 45)
R. 23 E.
3 050 000 FEET
(Joins inset, sheet 49)
T. 27 S.
390 000 FEET
388 000 FEET
(Joins inset)
MISSOURI KANSAS TEXAS
Pawnee
Creek
19
20
21
22
23
3 030 000 FEET
2000 AND 5000 FOOT GRID TICKS
CRAWFORD COUNTY


(Joins sheet 46)
R. 23 E.
R. 24 E.
3 075 000 FEET
392 000 FEET
390 000 FEET
T. 27 S.
(Joins upper right)
(Joins sheet 51)
Creek
Pawnee
Little
SAN FRANCISCO
ST. LOUIS
23
24
19
20
21
3 055 000 FEET
2000 AND 5000 FOOT GRID TICKS
CRAWFORD COUNTY


(Joins sheet 47)
R. 24 E.
R. 25 E.
3 080 000 FEET
T. 27 S.
(Joins inset, sheet 50)
(Joins inset)
Richland Creek
West Fork Dry Wood Creek
Walnut Cr.
3000 AND 5000-FOOT GRID TICKS
CRAWFORD COUNTY
3 100 000 FEET
390 000 FEET
22
23
24
19
20


(Joins sheet 48)
R. 25 E.
3 105 000 FEET
T. 27 S.
(Joins upper right)
West Fork Dry Wood Creek
W. Fork Dry Wood Cr.
Cox Creek
SAN FRANCISCO
ST. LOUIS
4000 AND 5000-FOOT GRID TICKS
3 120 000 FEET
390 000 FEET
MO.
CO.,
VERNON
CRAWFORD COUNTY
20
21
22
23
24


N
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
0.5
Scale 1:20000